GAS JOURNAL

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A NATIONAL FUEL POLICY

DURING the last 20 years there have been several more or less half-hearted attempts to set up advisory committees to formulate a National Fuel Policy. Sir Ernest Smith returned to the subject in an Address to the North Western Fuel Luncheon Club in Manchester. Assuming that the nationalization of the Gas Industry is to follow in due course that of coal and electricity, this would seem to be a golden opportunity to set up a National Fuel Board with real executive authority to pull the three services together. They are, he said, one national service, a public utility with its three branches, complementary, interdependent, all depending on coal, the one natural source of energy available in this country. Sir Ernest dismissed the future possibility of the utilization of atomic energy as entirely irrelevant to the formulation of national fuel policy.

His conception of a National Fuel Board is fundamentally different from that of the existing National Coal Board or the National Electricity Board which is shortly to come into being. These are functional boards—*i.e.*, composed of members each responsible for one or other department of the organization. No doubt the National Gas Board—he would have a Gas and Coke Board—would be similarly constituted. But superimposed above these he would have a small board responsible only for the formulation and carrying into effect of a national fuel policy—a "policy-mongering" board.

He even suggests that the new Gas Board should be constituted on a non-functional basis. He visualizes each region with its general manager, chief engineer, production engineer, technical director, distribution engineer, and accountant. Each region would make its own recommendations to the central gas board and these recommendations would be accepted unless they cut across the national fuel policy. We have made objections to this before. It means withdrawing from the Industry (assuming Heyworth's 10 regions) some 40 or 50 experienced officials. There is no reason at all why a small central Gas Board should not be sufficient without any serious disturbance of the existing set-up of the Industry, except that the obvious amalgamations and integrations would be carried out as and when they appear necessary and advisable. But apart from this there will be no disagreement with the proposition that an overriding fuel policy is absolutely necessary and that a body should be set up to formulate and enforce it.

There are, however, some inconsistencies, we think, in Sir Ernest's argument. We are not sure, for example, that the policy of the controlling body should be to give all consumers freedom of choice as to the fuel and equipment they shall use. Is the consumer capable of making a wise choice, or can he be relied upon to make a choice in the best interests of the national fuel economy? Obviously not. The choice of the correct fuel for a given purpose is a technical matter. The choice of the colour, shape, appearance of the appliance to use the correct fuel is a matter of taste. Technical questions are for the decision of technicians, taste may be left to the consumer. As Sir Ernest remarked, there will be no place for high pressure salesmanship in the new regime. Public utilities will not be judged by the growth in their sales. It may well be that the objective will be lower sales at a higher efficiency. We should see the end of the silly situation in which a local authority lays out a housing estate equipped exclusively for one or other of the fuel services in which it is financially or politically interested, regardless of fuel economy or efficiency.

Nationalization of the Gas Industry may be regarded as inevitable. It will carry with it certain grave dangers. If, for instance, the direction of the Industry is taken out of the hands of existing personnel operating where they now are, subject to integration strictly local in scope, there will be the danger, or indeed the continuation of the existing danger arising out of junior officials going round, inspecting and reporting, not knowing what to recommend and finally making recommendations based on inadequate experience and perhaps influenced by interested parties. There will be the danger of a restriction of the liberty of criticism at present enjoyed by members of the Institution and its affiliated District Associations. There is the risk that the Gas Research Board will be submerged in an amalgamation with the Fuel Research Board and the British Coal Utilization Research Association, both of which are too much absorbed with the study of solid fuel to have much time for gas. And, we repeat, there is urgent need for a powerful lead to the Gas Industry so that it may be able to gain and keep its rightful place in the counsels of the Ministry.

WHAT HAPPENS IN THE CONTINUOUS VERTICAL?

A CONSIDERABLE amount of light has been thrown upon the precise happenings within the continuous vertical retort in three recent Papers, that of Drs. Haffner and Weston on the "freezing" of working retorts at Nine Elms in 1943, that of Mr. Chisholm on the new sector discharger at Slough, and that recently presented to the Southern Association by Dr. Weston on the "freezing" of two W.D. retorts at Bow Common. We link the three together because they all raise the question whether what may be termed the "profile" of the retort, that is its internal shape, was in all cases exactly "correct" for the expansion

and other physical properties of the coals under treatment. And what would be "correct"? We imagine that the internal shape of the retort, its taper on both axes, would be best adapted to its purpose when the charge at all levels would be substantially in contact with the walls of the retort at all points and yet not so tight as to interfere with the regular descent of the charge.

The picture that one forms in one's mind of the charge in a continuous vertical is that of a flattened inverted conical core of coal extending some 15 or 20 ft. down the retort, bounded by the plastic layer through which every piece of coal would pass becoming coke on the outside of the cone. The experiments at Nine Elms and Bow Common have shown that this is not a wildly inaccurate picture. It is complicated by "much relative movement of different parts of the charge as it travels down the retort," as revealed by the position of the tallies, though the general nature of the charge indicates that this movement occurs only within the coal core. The outer layer of coke, once formed, is shown to travel down as a substantially unbroken monolith, albeit cracked and fissured at right angles to the long walls of the retort. Whether these cracks are present in the working retort or only appear on "freezing" may be open to doubt. And the same question may be asked about the split in the centre of the charge at the bottom observed in one retort at Bow Common and not in the other. That the coal core extended to at least 20 ft. down is held to mean that minor axis taper should extend at least to this depth, and Dr. Weston's view is that it should generally extend to the full length of the retort. But exactly what that taper should be and whether it should be the same for all coals and for all working conditions (that is, for all degrees of "steaming") is open to question.

There are difficulties in the carrying out of this class of experiment. The object is to arrest suddenly the process of carbonization to expose the charge exactly as it would be if nothing else happened except a drop of temperature to that of the atmosphere. At Nine Elms the time lag between stopping working and reaching the lower temperature was so long that the residual though declining heat of the charge prolonged the process. At Bow Common the lessons learned at Nine Elms were so effectively applied that to all intents and purposes success was achieved. Within, say, two hours, rigor mortis had set in, and although the post mortem examination was postponed for several months there is reason to believe that the charge remained practically as it was under working conditions. Before quenching, the use of "multi-metal" tallies—that is, tallies of metals or mixtures of metals with known melting points—gave a very fair picture of the internal temperature of the charge at various depths. That this increased from 400° to 500°C at 9 ft. down to just over 1,000°C at 21 to 25 ft. is in accordance with previous observations, mostly indirect though these have been.

Dr. Weston's general deductions will no doubt receive the respectful attention of designers. The taper of the retort has already been referred to. Is there not something to be learned about the shape of the profile in plan, the effect of corners? The position of the coal box directly over the retort is now generally accepted as ideal, but it calls for considerable ingenuity in providing for adequate access to the interior of the retort—e.g., for rodding and scurfing.

Of one thing there is no doubt. These very valuable and fascinating experiments can only be carried out by very large undertakings with plant to spare and highly skilled personnel to carry them through. That the results are so freely placed at the disposal of the whole Industry is a very pleasant exhibition of helpful co-operation.

WATER TREATMENT

As with most gas-works plant it is of the greatest importance that the boilers should be kept in service for a very high proportion of their working life. They must have the highest possible factor of availability. At any rate it should be possible to keep boilers steaming continuously until statutory requirements render it necessary for them to be laid off for inspection. The ideal would be reached if internal cleaning could be rendered altogether unnecessary. This ideal cannot be approached if the boiler itself is used as "the chemical reaction tank" in which water treatment is more or less completely carried out. If this is true of the Lancashire boiler it is more important still in the waste-heat boiler upon which the modern gas-works more and more depends for a high proportion of its steam supply. For while it is obvious that hard scale on the outside of tubes reduces the rate of heat transfer, deposits of sludge are also detrimental and there is serious loss of heat in the blow-down required to remove it, whether continuously or periodically.

The problem of water treatment is most acute in hard water districts such as that in which Mr. Philip Wedgwood is working, the area served by the Watford & St. Albans Gas Company. His Paper "Practical Progress in Water Treatment" presented to the Eastern Association at Chelmsford was an admirable description of methods used with success with a feed water drawn from the chalk measures and from the river running over them.

The objects sought were the elimination of scale formation by the removal of calcium and magnesium salts as completely as possible, particularly the silicates which constitute the hard scale adhering to tubes and which are difficult of removal especially from the tubes of waste heat boilers, the reduction of total solids in the feed water to the minimum to reduce blow-down with its attendant losses of heat and treated water, and to avoid the possibility of corrosion; and to achieve all that with the simplest possible plant both in maintenance and control. Success was achieved in a fine example of collaboration between operators and contractors. Briefly, the process adopted was a combination of lime-soda treatment with a carbonaceous zeolite filter. No other form of filter is used. The sand filter was purposely avoided on account of possible troubles with silica. And with careful control of the rate of flow no difficulty was experienced.

It is interesting to note that Mr. Wedgwood does not subscribe to the view that a certain minimum hardness should be retained to avoid corrosion. In his opinion, and he is justified by his results, perfectly clean boilers, both internally and externally, can be used with safety. The deleterious constituents can be removed from the water outside the boiler, "where it should be done." And he holds that "corrosion inside the boilers will be avoided—without the necessity for supplementary treatment of the water before it enters the boilers." Both the Lancashire and the waste heat (fire-tube) boilers are free from any signs of corrosion. It will be admitted, too, that the cost of 7d. to 8d. per 1,000 gallons of water—less than a penny per 1,000 lb. of steam—is comfortably low. Mr. Wedgwood and his Company are to be congratulated on a very nice piece of technical work resulting in an improvement on their already well-known high level of efficiency.

1947 "JOURNAL" DIRECTORY

In order to keep the Directory information up to date, the following alterations and corrections which have been notified during the past month should be noted in the 1947 issue of the "JOURNAL" Calendar and Directory:

Page 14. BRIDGNORTH GAS DEPARTMENT. S. R. Bennett, *E. and M.*
„ 88. DUNDEE GAS DEPARTMENT. J. Duffy, *Asst. E. and M.*

Obituary

Mr. **G. M. Gill,** Managing Director of the Severn Valley Gas Corporation, writes the following appreciation of Major JULIAN DAY, M.C., Chairman of the Severn Valley Gas Corporation and Gas Consolidation, Ltd., whose death on June 16 was announced in the "JOURNAL" of June 18: Major Julian Day was the founder of these holding companies and also of the South Eastern Gas Corporation, of which he was a Director from its inception 15 years ago. He had been suffering from ill health for the past year and passed away in Lugano, where he had gone in an effort to regain his good health, but it was not to be. I was closely associated with him throughout his connexion with the Gas Industry and from the day when he decided to purchase a controlling interest in the small holding company comprising the Folkestone, Deal and Walmer, Whitstable and East Kent Gas Companies, which grew later into the South Eastern Gas Corporation. He was a very able business man, with fine judgment particularly in financial matters. His guidance in this respect was uncannily sound. He was also a very straightforward man and throughout my long connexion with him he set a fine example of honesty in all his dealings. He was very human and if he thought he had been a little impulsive he put everything right with the kindest of letters. Some of us will miss him very much indeed.

Letters to the Editor

German Union of Gas and Water Works

DEAR SIR,—On June 10, 1946, the Union of Gas and Water Works in Wurtemburg and Baden included in their general meeting commemoration of the foundation of the Gas Institute. A small but highly qualified and interested circle of people were present. After various greetings and congratulations, I gave a report on the work of the Institute, which was founded as an educational and research institution and has always linked research with education. Above all, it has trained the chemist not only for theoretical work in the laboratory, but also for practical work. This, if I may say so, explains why an unusually large number of students have taken their places in leading positions in the Gas Industry and in other branches of chemistry.

As a foundation the practical work involved in the investigation of gas-works processes in general and of individual items of plant was of importance. As example, the chemico-technical control of the gas-works in Karlsruhe has for 25 years given students the opportunity of practical training, and their academic work is well known.

The precepts which to-day are recognized in all countries originated to some extent through the co-operation of the Gas Institute. The war changed the position of the Institute fundamentally, especially since its creator, Professor Karl Bunte, died in November, 1944. All the same, the Institute did not permit interruption of its activity, and now, I am glad to say, the training of younger students has been resumed. The Institute has a considerable number of research workers and holds refresher courses twice a year regularly. Apart from this it has assisted the State Technical Colleges to run courses in gas technology with the aim of producing qualified gas engineers.

Academic research can, in existing circumstances, proceed only slowly, but it has been properly registered with the Military Government and is being followed up vigorously. The finances of the Institute come at the moment from voluntary sources, from various gas undertakings, and from remuneration for work which the Institute has been commissioned to undertake. I thank you in anticipation of publishing these few comments.

Yours faithfully,
J. KORTING.

Karlsruhe.
June 21, 1947.

Diary

July 3.—Solid Smokeless Fuels Federation: Executive Committee, Dorchester Hotel, Park Lane, W.1, 11.30 a.m.

July 5.—Western Junior Gas Association: Summer Meeting. Lunch, Gloucester, 12 noon; coach tour to Stratford-on-Avon; tea, Memorial Theatre, 4.30 p.m.

July 8.—National Federation of Gas Coke Associations: General Committee, 10 a.m. Gas Industry House.

July 9.—National Federation of Gas Coke Associations: National Technical Committee, 11 a.m. Gas Industry House.

July 9.—London and Counties Coke Association: Technical Committee, 2.30 p.m. Gas Industry House.

July 22.—Industrial Gas Development Committee, Gas Industry House, 2.30 p.m.

"GAS SERVICE"

"GAS SERVICE" has in its present guise, and previously as "THE GAS SALESMAN," kept an accurate and enlightened finger on the sales pulse of the Industry for the past quarter of a century. Throughout that time it has maintained its individual personality, has upheld its own clearly defined editorial policy, and has endeavoured to furnish all followers of the Industry with an unbiased, up-to-date, and informative guide to a gas service. This column, briefly describing some of the contents of the July issue, has been included in the "GAS JOURNAL" make-up because it is felt that gas engineers who do not have the opportunity to peruse our pocket-size contemporary nevertheless need some indication, however brief, of the activities of the selling side.

The American Scene

Month by month we publish reports of the Industry in the United States, and because of their authoritative and outspoken nature, these glimpses of American trade have become extremely popular. It seems shortages of pipe and distribution equipment are paralyzing gas business across the Atlantic in a manner similar to our own. This, and such diverse topics as new uses for coal, commercial radio, and the laying of a new 1,000-mile aluminium natural gas pipeline are dealt with in typically breezy fashion.

Incubation by Gas

The Hebden Royd Area is justly famed for poultry rearing and the local Gas Department naturally has taken a particular interest in the way gas can assist this industry. As a concise and obviously knowledgeable treatise on the subject, W. Shryne's Paper, "Gas and Poultry Rearing," to the West Riding Circle would take some beating. Here are the facts, including complete running costs, and we feel this Paper cannot fail to interest undertakings who specialize in this rather unusual load—and, incidentally, some who have left this source of revenue untapped.

Gas in the Home

Mrs. G. E. Abbott, until recently the Organizing Secretary of the Women's Gas Council, has, with her charm and knowledge of the Industry, become one of the better known personalities in the gas field. It would be expected therefore that a Paper of hers to the Royal Society of Arts would be informative, well-constructed, and to the point. "Gas in the Home" is all of these and serves as an admirable assessment of domestic heating needs to-day and their fulfilment by gas. Incidentally, it firmly hammers home the fuel economy argument with regard to the present coal crisis.

The Way Ahead

It is inevitable in these days of uncertainty that we turn anxious eyes to the future, for our Industry is facing possible Government supervision and keener competition. The first factor is rather beyond the control of most people, but the latter is the concern of everyone. It is very much the concern of J. W. B. Hyde, who in a Paper to the Home Counties (Western Area) Circle reviews every type of domestic gas appliance, its advantages and drawbacks in comparison with its electrical counterpart, and its chances of success. The Paper makes particular reference to the adoption of a two-part tariff and gives significant figures to show its success in the Author's own district, Yorktown.

Female of the Species

Women's place in the Gas Industry—or anywhere else for that matter—is a subject which seems destined to bubble up in volcanic fashion from time to time. At the moment we appear to be on the crest of such a wave, for much of our issue this month is devoted to the steady and valuable work of our lady colleagues, including a full report of the Annual General Meeting of the Women's Gas Council. There is also a plea for more appreciation of women and, in contrast, a strongly-worded defence of the salesman. The latter is occasioned by the inclusion last month of an article entitled "Women in the Showroom," which made out a strong case for the increased employment of women in a selling capacity. This had apparently put the men on the defensive and we publish this month, to show our impartiality, "Men in the Showroom," which sets out to show exactly why men are better suited to serving women customers, understanding their needs and giving equally sympathetic treatment to all. The controversy is an interesting one and its significance is examined in the editorial columns. It is not our purpose to lay down a definite ruling, for to do so would be a negation of our function; rather, we seek to underline and emphasize here and there, revealing new aspects of the subject and making such suggestions as appear to us fair and necessary. Also receiving editorial comment is the exhibition arranged by the British Gas Council to publicize the uses and advantages of infra-red drying.

Commentary by "Abaris"

Complete Gasification

There are good and powerful arguments for and against complete gasification, and I am sure that protagonists and opponents will continue their wordy warfare for many months to come. But let us not overlook the immediate needs of consumers. Thousands of homes have coke-fired boilers which give each family nearly all the hot water it uses, day in, day out, at a relatively low cost and with not a great deal of trouble—with the small proviso that the coke is available and obtainable. If the Gas Industry could supply the gas appliances, and guarantee enough gas to keep them working satisfactorily, well and good; the Industry might then, after a reasonable period, cease to supply coke and transform it into gas—and, incidentally sell this gas at an economic rate. This is quite an ordinary suggestion and I hesitate to put it forward; I do so, however, because I am a member of the public who dislikes our cold, damp climate. Age demands comfort, and, as one sapient member of the Government pointed out recently, everyone is getting older. This is a profound thought, an undeniable fact.

Oil

In great Britain we have plenty of coal; the trouble is that it is underground. So we have recourse to the use of oil for gas making. Where does this oil come from? Is our money spent in the hard currency countries? The answer is that oil buying sends our pounds, shillings, and pence overseas. It is a sorry day for us when we have to substitute imported oil for our native coals; an all-British industry has to lean on friends for raw materials. Let us take the long view and ask, what if oil is denied us or becomes too expensive to purchase as our foreign exchange coffers dry up? America is worried about her oil assets, which, like our coffers, are running out. Maybe we are not thinking about to-morrow and the day after, although all life is founded on the hope of a to-morrow. National life should look further ahead.

Persuasion

One can create a market by advertising and by other forms of propaganda, and while there's money about, selling is a relatively easy process, with, possibly, high profits. The fuel supplying industries are in a curious position to-day when there is a good deal of money waiting to be spent. Many thousands of pockets and hand bags are stuffed with the means of exchange, but as most things are limited in some way, money cannot be freely and reasonably spent. Comfort can still be purchased at a price, and, taking our own narrow view as fuel suppliers, we shall find that our gas is all too easily used. Coal is rationed and many people have no hope of getting even their just ration before the winter descends on us. Most of these will endeavour to turn on the gas and, so to speak, hang the cost. Few people will read their meters, for two reasons: first, they will not be bothered; and second, many meters are put in the most awkward and un-get-at-able places, which, of course are not conducive to ready inspection. Can we, or can the Ministry of Fuel and Power with its peculiar advertising, get people to cut down the use of gas? The requirements of physical comfort far out-weigh the immature blandishments of the Ministry. The average person may starve and he may be taxed out of existence, but he wants to be comfortable while he's doing it. None can persuade a shivering family that it is good to shiver, for the physical is more potent than the psychological stimulus.

District Heating

Some years ago a special Committee was appointed by the Institution of Gas Engineers to study district heating. This body is still studying it. Will it continue to do so until the sands of time run out? Many problems are studied; they are examined and then they are soft-pedalled in the hope that the subjects will be forgotten. On the other hand the electricians push on; they strive to prove to architects that district heating from thermal-electric generation is the most economical way of supplying really cheap warmth to shivering humanity. What the electricians hope to do is to push up the percentage of useful heat they extract from coal. At present 20% is their limit and district heating may push this up to 40%. Thus they hope to bring about a domestic revolution; and they are making an impression with their overtures. Gas and coke production, on the other hand, has a thermal efficiency of about 80%. It employs coal economically. Do we need a committee which does not suffer from "gastrophobia" and the modesty that goes with that awful ailment?

Research

I am always fascinated by the erudite papers read at some of the Gas Industry's meetings and conferences. Polymerization, catalysts, poly-vinyl, and *p*H mean nothing to me for I am among that long-suffering body of humanity called laymen. Likewise, I am fascinated by streptococci, specific performance in law, weighted averages, commutators, plutonium, and the whole galaxy of specialist words and phrases. They sound so mighty as they assail my stapes, incus, and malleus—sorry, my ear. As I look round at gas conferences, I feel that there are very many like me. If research as carried out by some of the larger undertakings benefits the smaller, then I rejoice; if some of that research assists the consumer, then a sparkling achievement is made evident. Some of the high powered work done in recent years might well have been left to the appropriate Government laboratories, where life is timeless.

Purchase Tax

Now that the purchase tax on gas cooking appliances has been cancelled by the Chancellor we breathe more easily. It must be obvious now that the Chancellor was either ill-advised or that he refused to take advice. The total which would have been yielded by the tax in the form of revenue was negligible, and it is difficult for anyone to understand the mind that loads more weights on the heavy-burdened public. Councils will be thankful for the respite and can now concentrate on the urgent business of finishing homes for the needy who have been waiting so long, and so patiently. In many cases the tax would have meant an appreciable increase in the rentals of such houses that were about to be finished. How customers who have bought an appliance will be able to prove their entitlement to a refund is a problem which is going to crop up all over the country. There is a moral here and that is, do not be in such a great hurry to connive at any imposition that is discriminatory and unfair.

Man Management

The employer in days of yore knew his workmen and they knew him; thus was the prosperity of Great Britain built up. There was a mutual confidence and trust among a vast number of workers and employees, in a wide range of industries. Some employers erred from the honourable paths laid down by their fathers, and so came industrial unrest. This is the story without any trimmings about the Truck Acts, Trades Unions, &c. There are still some of these personally managed companies in this country, dealing in all sorts of manufactures; there is, indeed, a number of gas undertakings where the spirit of co-operation is much alive. On the other hand there are undertakings, including a proportion of large ones, where the word co-operation is used only once a year; at the general meeting. It seems that dignity is the element among some of the managements which stops any spirit of friendliness. The aloofness so characteristic of some managements does their workpeople no good at all. The common workman is grateful when he meets someone from Head Office, and it gives him something to talk about. Such a meeting has a vast psychological value, for it shows the employee what kind of being helps to rule the undertaking that they both serve. It also enables the management to understand the employee's point of view.

NORTH WESTERN FUEL LUNCHEON CLUB

On June 18 Sir Frederick J. West presided at the last meeting of the 1946-47 session of the N.W. Fuel Luncheon Club and the last of his Presidency. The guest speaker was Sir Ernest Smith, who spoke on the need for a national fuel policy. His suggestion was that there should be a National Fuel Board responsible to the Minister for the development and enforcement of a national fuel policy. It should be non-functional in character. Subject to it would be three boards —the present National Coal Board responsible for the production, preparation and sale of coal; an Electricity Board for the production and sale of all electricity with power to buy from private generators; a Gas and Coke Board for gas production, distribution and sale of gas, coke and by-products including cove ovens. The fuel industries should be regarded as one public service and fuel research should be transferred to the Ministry of Fuel and Power.

At the close of the meeting Sir Ernest received from the President contributions to the Building Fund of the Institute of Fuel, cheques amounting to £214, a sum which included 50 guineas from the Luncheon Club funds, 50 guineas from the Manchester Electricity Department, with the balance from private members of the Club. Sir Ernest remarked that he had been assured that the Ministry strongly approved of the setting up of the new headquarters of the Institute and would raise no objection to donations from public utility undertakings interested in fuel.

News in Brief

Evered & Co., Ltd., have removed their London office from 293, Regent Street, W.1, to 23, Albemarle Street, W.1.

The Ministry of Fuel and Power has informed Darlington Corporation that it would be in a position shortly to discuss the Council's request for a supplementary supply of coke oven gas.

A Deficit of £72,421 on the working of the Leeds Gas Department is shown in the accounts for the year ended Mar. 31. The deficiency last year was £11,641, compared with a surplus of over £13,000 in the previous year.

Darlington Corporation has applied for sanction to borrow £14,510 for new plant at the gas-works, including £2,635 for precipitation plant, £4,225 for an ammonia washer, £2,550 for compressor, and £5,100 for station meters and meter house.

Billingham-on-Tees Urban Council has pressed the Stockton-on-Tees Gas Department for a reduction in gas charges in the Billingham, Wolviston, Cowpen Bewley, and Haverton Hill areas to bring them more into line with the charges in the Stockton and Thornaby areas.

Otley Council has reversed its decision not to provide gas cookers on its new housing estate as a result of the purchase tax concessions. When the tax was imposed in the Budget the Council decided not to obtain the cookers, but now it has restored them to the specifications.

Several Members of the Architectural Staff of the Dagenham Borough Council visited the Watson House laboratories of the Gas Light and Coke Company on June 25. This visit followed one made a short time ago by other officials of the same Council who were interested particularly in central heating and the fuel problems connected therewith.

A New Company, Bloxwich Domestic Boilers, Ltd., Willenhall Lane, Bloxwich, has been formed by Tom Carrington & Co., Ltd., West Bromwich, for the manufacture of domestic boilers in copper and steel. It is hoped that copper boilers will be in production within the next few weeks, and the Company is now open to receive orders for reasonable delivery.

Substantial Export Orders have been received for the engineering plant and equipment stored at the main collection depot for war surplus at Avant-Port, Brussels, recently acquired by George Cohen, Sons, & Co., Ltd., from the Ministry of Supply. The depot, which covers eight acres, contains over 3,000 items, many of them still in the original makers' packing cases. Sample items are available for inspection either at the Company's Wood Lane, London, or Stanningley, Leeds, works. Importing to this country is permissible provided the necessary licence is obtained. A catalogue has been printed and among the items it lists are lighting sets, petrol engines water purification sets, contractors' pumps, trailer fire pumps triple ram pumps, and deep well pumps.

Negotiations are Taking Place for the handing over of Falkland Gas-works, Fife, to a local company, and although the month's notice to close down the works expired last week, it will remain open meantime. When the owner, Mr. J. R. Stevens, stated that he could not produce gas economically, owing to the shortage, price, and bad quality of coal supplied, he gave notice to the Town Council that he could not guarantee to provide gas after June 19. Most of the townspeople use gas for cooking, and the Town Council sent a protest to the Ministry of Fuel and Power. Mr. Stevens has had no word from the Ministry, but, in an interview, he stated that two or three people in the town had shown an interest in the works, and it is expected that a company will be formed to take it over.

Under the Leadership of Mr. W. J. Hall (Distribution Department Superintendent) and Mr. A. W. Moss (Showroom Manager), of Redditch Gas Company, 60 members of the Redditch Ladies' Gas Circle visited the Aston works of John Wright & Co., Ltd. (Radiation Ltd.), on June 11, and were shown round the mechanized foundry, pattern shops, tool room, and various production departments. The visitors were fascinated by the pouring of molten iron in the foundries and took a keen interest in all that they saw, asking many questions that disproved the popular idea (among men) that the gentle sex have no understanding of mechanical or technical matters. One of the ladies summed up her impressions of the visit by remarking that she would never again use her cooker without thinking of all the skill and toil that went into its making.

Gas Consumption at Middlesbrough was 10% less in May than in May, 1946. This has been attributed to the fuel economy campaign.

The Trade Statistics for January, 1947, just issued by the Department of Industry and Commerce in Eire, show imports of 18,249 tons of gas coal, valued at £55,467, as against 16,680 tons, valued at £48,219, in January, 1946.

Tenders for the construction of new vertical retorts at Stockton-on-Tees are to be considered by the Corporation this month. Representatives of the undertaking are visiting other centres, including Preston, Stoke, and Lincoln, to inspect vertical retorts there.

Nottingham Gas Department anticipated a 6% increase in normal consumption over the past seven weeks, but the actual increase was only 1%, reported the Engineer and Manager, Mr. R. M. Wilkinson, last week. The consumption of gas in the city for the period ended June 14 rose from 593 million to 600 million cu.ft.

A Further Extension of gas supply to embrace the village of Keresley is under consideration by the Coventry Gas Department. This was mentioned by the Chairman of the Gas Committee, Alderman J. Howat, when he opened an exhibition of modern gas equipment at Keresley. The people of the village had by a majority expressed themselves in favour of a gas supply.

Johnstone Town Council has undertaken to supply gas to Beith and Kilbirnie, and tenders for the pipe-line are to be invited. This supply from Johnstone will mean cheaper gas for Beith and Kilbirnie consumers. With Johnstone going ahead in the production of gas and the extension of its area of supply, it is essential that improvements should be carried out at the gas-works. At a recent meeting Mr. A. Jamieson, Engineer and Manager, submitted plans showing an up-to-date type of gas-works building. The plans were generally recommended for approval by the Committee, so that Mr. Jamieson could work out details which would provide for an ultimate increased output from 1,250,000 cu.ft. up to 3,000,000 cu.ft. per day.

STEEL TUBES AND TUBULARS

The Gas Industry will be interested to have advance information on a new British Standard Specification for Steel Tubes and Tubulars which is shortly to be issued. The Specification cancels all previous specifications for steel tubes and tubulars suitable for steam, water, and gas services. The new Specification differs considerably from those previously in use, in that (*a*) it provides for three thicknesses of tubing, one of which is very much lighter than any previously specified; (*b*) no indication is given of the uses for which the new classes of tubes are suitable; and (*c*) the distinguishing colours for all of the three weights of tubing are entirely different from those previously used.

Prior to the war, British Standard No. 789-1938 provided for three weights of tubing universally known as steam (heavy), water (medium), and gas (light) qualities. During the war, to effect economy, a War Emergency British Standard No. 789A-1940 was issued. This temporarily cancelled B.S. 789 and included only two weights of tubing, known as heavy weight and light weight. The heavy weight was equivalent gauge and weight of the pre-war water weight and the light weight was one gauge lighter than the pre-war gas weight.

The new British Standard No. 1387-1947 provides for three weights of tubing. These are to be known as Class C, Class B, and Class A. Class C is the equivalent gauge and weight of pre-war steam weight; class B is the equivalent gauge and weight of pre-war gas weight; and class A is an entirely new and extra light weight tube, actually two, and in some sizes, three gauges lighter than the pre-war gas weight.

Changes in the identification colours and in the grade descriptions were made with a view to preventing any confusion with tubes made to the previous specifications and to ensure that only tubes of suitable thickness are used for the various services.

The new very light weight class A tubing is considered unsuitable for the conveyance of gas, and all Codes of Practice and Regulations governing the installation of gas services and gas installation supplies will be brought into line with this new British Standard and specify class C tubes for underground work, services, &c., and class B tubes for surface work, installation supplies, &c. To ensure that only tubes of suitable thickness are used for the conveyance of gas, undertakings will no doubt feel it desirable to bring the new conditions to the notice of all contractors, plumbers, and others carrying out installation work

COAL POOL FOR EIRE

All gas companies in Eire, with the exception of Dublin and Cork, will be represented on a special Coal Pool Committee, shortly to be elected, to handle the distribution of coal to their Industry. The object will be to ensure equitable distribution of available coal, and also to work out plans for eliminating Dublin as a central coal dump, and arrange for supplies to be shipped direct to the ports nearest the different gas-works throughout the country. This will mean the avoidance both of delays and of expensive freight charges.

Wexford Gas-works is still making the only foundry coke in Ireland, from U.S. coal. So far 40 tons have been made, and now the Company is awaiting a direction from the Department of Industry and Commerce as to how much it is expected to produce per week. The potential capacity of the gas-works, if four of the six retorts were to be put on whole-time coke production, is 80 tons a week.

Supplies of foundry coke ceased when the Durham coal ceased coming in last February.

Mr. H. W. Saville, Managing Director of the Wexford Consumers' Gas Company, said that the Alliance and Dublin Consumers' Gas Company would shortly follow Wexford into the production of coke for the foundries as it was not very sensible to send the coal all the way to Wexford and then to send the coke back to Dublin.

POWELL DUFFRYN DEVELOPMENTS

Two developments affecting the future organization and expansion of their subsidiary companies are announced by the Directors of Powell Duffryn, Ltd. They follow on the acquisition of a freehold factory at Hayes, Middlesex, in February, and the formation in March of their new Company, Powell Duffryn Technical Services, Ltd.

The first of the developments now announced is the registration of another new company to be known as Powell Duffryn Carbon Products, Ltd. This company will carry on in the Hayes factory the commercial production of carbon products which has previously been conducted in an experimental and development stage at Battersea by Delanium, Ltd., also a subsidiary of Powell Duffryn, Ltd.

The second development concerns the future of the Delanium laboratories, at Battersea. In connexion with the general future requirements of the Powell Duffryn Group and particularly of Powell Duffryn Technical Services, Ltd., which is already developing at home and abroad, it is necessary to have a comprehensive research organization capable of conducting original research and of testing the results on a semi-commercial scale.

The premises at Battersea are particularly suitable for this work, and as the name of Delanium has been associated with the range of carbon products to be manufactured at Hayes, it is thought desirable to alter the name of Delanium, Ltd., to one which is more indicative of the nature of the activities which will in future be carried on at Battersea; the name of Delanium, Ltd., has accordingly been changed to Powell Duffryn Research Laboratories, Ltd.

GAS IN RURAL AREAS

Under the auspices of the British Gas Council the Merlin Film Company has started work on the production of a film on "Gas in Rural Areas," and has chosen the Cotswolds as an ideal background. Although Chipping Campden, Stanton, and Broad Campden will adopt anonymity in the film—which will ostensibly record the advent of gas to an imaginary composite village—lovers of the Cotswolds will have little difficulty in recognizing the Wool Market or the Old School House at Chipping Campden.

Mr. Gilbert Gunn, whose experience in film directing has included not only feature films but a documentary on the thousands of displaced persons in the Middle East, turned down the idea of employing professional actors for the parts of local characters. Instead, he sought the services of local amateur dramatic societies, and the cast of "Gas in Rural Areas" has been largely selected from the Cheltenham Civic Players and the Chipping Campden Amateur Dramatic Society. The film will be a silent one, but a commentary will be added in the studio.

The story of the film concerns the actions of a district nurse who, because there was no gas for lighting or heating, felt that she could not carry out her duties efficiently, complained to the doctor, and thus set in motion a snowball of complaints which led to the introduction of a gas supply.

Shots will be taken in the board room of the Cheltenham and District Gas Company, when representatives of the Parish Council, after a public meeting in their school, appeal to Mr. A. L. Morris (who appears as himself) to extend gas facilities, assuring him of a custom sufficient to warrant the outlay. Mr. Gunn will travel with his production manager, Mr. Arthur Barnes, and his two cameramen, Mr. Jack Flack and Mr. Harry Oakes to the Atlas Works at Pershore, to film the important part taken by gas in the manufacture of agricultural machinery.

NEW NORTH CHESHIRE GAS-WORKS

The Ministry of Fuel and Power has given its approval to the first step in a £3,000,000 scheme planned by the United Kingdom Gas Corporation for re-organizing and radically increasing gas production facilities in the North Cheshire area. In fulfilment of that part of the scheme which has been approved, work is to start immediately on the erection of a large new gas-works at Denton, to be operated by the North Cheshire and District Gas Company, a U.K. Gas Corporation subsidiary. This initial unit will cost £1,250,000, will have a capacity of 6 million cu.ft. of gas per day, will process 400 tons of coal a day, and will take four years to complete.

When completed it will be used in conjunction with the present works at Hyde as the principal supply source for the North Cheshire and District Gas Company's system of inter-connected mains that serves the Denton, Hyde, Dukinfield, Hollingworth, and Broadbottom areas.

The full scheme which it is proposed to spread over a period of years will involve a total outlay of £3,000,000. It is planned to treble the first unit at Denton, making it one of the largest single gas production plants in the world. Thus expanded, the Denton plant will process 1,200 tons of coal daily, yielding 18 million cu.ft. of gas, 660 tons of coke, and 60 tons of tar.

Colonel W. Moncrieff Carr, Managing Director of the U.K. Gas Corporation, estimates that the full scheme will save the nation at least 200,000 tons of coal annually, since each ton processed will be made to do the work of 1½ tons burnt in the raw state. Of the additional supplies of gas which the new works will make available, rather more than half will go to existing industrial and commercial consumers, three-eighths to new industrial consumers and the remainder to new housing estates scheduled for building in the area.

FRONT LINE COMPANY AT WAR

Under the title of *Reflections*, 1939-1946, the Eastbourne Gas Company has published a remarkable chronicle of its wartime experiences. It is the story of one of the many gas companies which carried on during the "dark days"—days and nights of struggle against the enemy bomber, the black-out, the shortage of staff, restrictions, and lack of supplies—and won through.

Up to September, 1940, the Company managed to get along quite well. The town was crowded with evacuees from the regions around London, supplies were still plentiful, and for a time the output of gas increased. A 12-in. main had been broken in Eastbourne and an 8-in. main fractured at Hailsham, but no one took these things very seriously. Then came Dunkirk; all the evacuees left and with them went everybody not engaged in essential work, under a Government Evacuation Order; and the output of gas dropped over 50% in a few days.

From that time until the end of the war there were 138 incidents involving broken mains, in addition to extensive damage at the works, but throughout the war the gas supply was completely cut off only on two occasions—within a few days of each other in the autumn of 1940. Tip and run raiders apparently placed the gas-works high on their priority list. Most of their bombs missed the works and caused damage to adjacent property, but on the few occasions when they did succeed they caused severe damage. Many of the incidents entailed deeds of great heroism.

Of the Company's permanent employees 138, or over a third of the pre-war staff, served in the fighting services; seven were killed in action and two were killed in enemy raids on Eastbourne; five were wounded and two were made prisoners of war.

"The most noticeable thing everywhere," it is recorded, "was the way in which difficulties which before the war would have been deemed insuperable were accepted and overcome as a matter of course, whether at the works, in the distribution department, or in the offices. Whatever it was, the work of the Company *must go on*, and that was the spirit which produced a real co-partnership, and which brought us through."

The wrecked holders have now been rebuilt, broken mains have been repaired, the offices are once more back in the Terminus Road premises which miraculously escaped serious damage by bombing, men on active service have nearly all returned to work and are rapidly picking up the threads again, the output of gas for 1946 beat all records, and a deficit of £36,000 which accumulated during the war has already been reduced by nearly two-thirds.

Burnley Gas Committee made its annual inspection of Oswald Street works on June 17. Repairs are in progress to bring the undertaking up to the highest efficiency for the winter. Councillor W. Smith (Gas Committee Chairman) reports that preparations had not yet started for a costly extension scheme which will mean an increased output of 2,000,000 cu.ft. per day. Mr. A. F. Ames, Engineer and Manager, and Mr. T. D. Olver, Deputy Engineer, took the party round the maintenance shops, water gas plant, and laboratories.

NEW PLANT AT ATHERTON

New plant, comprising an elevator, overhead storage bunker, combined retort charging and discharging machine, and mercury arc rectifier, has been installed at the works of the Atherton Gas Department, and was recently ceremonially inaugurated by Councillor O. Hatton, Chairman of the Gas Committee, in the presence of a large gathering of councillors, officials, and other visitors.

Coal is brought to the works by lorry and discharged into the receiving hopper of the elevator. The flow of coal from the hopper into the buckets of the elevator is controlled by a rotary feeder, so that coal can be piled over the hopper to eliminate as much as possible any hand shovelling. The elevator handles 12 tons of coal per hour and discharges into an overhead storage bunker supported on stanchions inside the retort house.

The combined De Brouwer charging and discharging machine travels on rails in front of the retort bench and is designed to operate on through retorts which now replace the previous stop ends. It draws supplies of coal from the storage bunker and a hopper on top of the machine allows a carrying capacity of about five tons. Thus, at least 10 retorts can be charged with but one filling from the storage bunker. By means of a system of pulleys and an endless belt, coal is projected into the retorts in a stream, 10 cwt. being charged in under a minute. The retorts are, therefore, out of action for the minimum of time and there is a resultant increase in the make of gas. Coke is pushed through the retorts by the ram of the discharging unit which consists of cast steel links connected to a solid first length. At the discharge side, coke is dealt with by a Chaseside mechanical shovel and removed into the yard. Both the charging and discharging units are assembled in a frame within the main structure of the machine and this frame is hoisted and lowered to deal with the various tiers of retorts. The coal plant and charging and discharging machine are driven by electric motors. The town supply of alternating current is converted to direct current 220 volts by means of a mercury arc rectifier.

Following the inauguration the guests were entertained to tea at the local British Restaurant, where the toast of the Atherton Gas Department was proposed by Mr. W. T. Duxbury, a former Engineer and Manager, and responded to by Councillor S. Loveless, Chairman of the Atherton Council.

Councillor O. Hatton proposed the toast of the contractors, Messrs W. J. Jenkins & Co., Ltd., of Retford. He said the new plant in addition to solving their labour problem had also improved the thermal efficiency of the carbonizing process, which simply meant that they were now able to obtain more out of every ton used at the gas-works. He was confident the new plant would give many years of good service, and he congratulated the contractors on carrying out the work under the most trying conditions.

Mr. R. W. Crowther, responding on behalf of the contractors, said he was glad to learn from Mr. Gallagher, the Engineer and Manager, that the plant was already producing good results in the form of more gas and more coke. They were getting 33⅓% more out of the plant than they did without the machine, and it would certainly ease the work of the men employed in the retort house. He congratulated the Council, Mr. Gallagher and his predecessor, Mr. Duxbury, and hoped that what the firm had done would justify the confidence the Council had so far placed in them.

NEWCASTLE COMPETITION RALLY

As a logical follow-up to its educational work during the war in conjunction with the Army Educational Authorities for the Forces (both male and female), the Newcastle-upon-Tyne and Gateshead Gas Company last month arranged a series of Home Management lectures for the British Legion Women's Section in Northumberland, as it was felt that this organization would now include in its ranks many of the young people who, because of war service, had been deprived of instruction in domestic matters through the normal channels.

Having enlisted the co-operation of the headquarters of the British Legion Women's Section, the Company invited each branch in the area to nominate nine members, from whom three were selected to comprise a representative team in a competition; one to make and bake a small cake; one to give a three-minute talk on "My Ideal Home"; and one to give a talk on "Health in the Home."

Mr. J. White opening the competition rally.

The response was overwhelming and it was necessary to restrict the number attending the series of lecture-demonstrations to nine from each branch, which assured an attendance of over 100 on each occasion. The scheme culminated in a competition rally which was attended by 400 women from the Northumberland branches, and the large Connaught Hall had to be engaged to provide sufficient accommodation. The highlight of the event was the cake making competition, the ten cookers in line on the platform for this event presenting an unusual spectacle. Prizes were awarded for each of the three contests, the silver cake basket for the best cake being won by the youngest competitor, 20-year-old Mrs. Joicey, one of three members of her family who entered. A high standard of architectural understanding was displayed in the ideal home talk contest, and the award for the health talk was equally well earned. The prizes for all three contests were silver cake baskets provided by the Gas Company, and they were presented to the winners by Lady Lambert, who was accompanied by Sir Arthur Lambert, M.C., J.P.

INFRA-RED HEATING BY GAS

Taken at the Infra-Red Heating by Gas Exhibition at Gas Industry House, the photograph on the left shows Mr. J. R. W. Alexander discussing some of the apparatus with Mr. William Leonard, M.P., who opened the exhibition, a general view of which is shown below.

THE NATIONAL FUEL SERVICE*.

IS THERE A PLAN?

By SIR ERNEST SMITH, C.B.E.

THESE are my personal views only. The Institute of Fuel has a Committee sitting on this question who will report in due course. But neither the Institute nor this Committee have any responsibility for the following:—

I make no apology for dealing with this subject before the North Western Fuel Luncheon Club. Northerners may be good politicians, but above all they are practical men and realists—and a sense of realism is required above all things to-day. In this Address I am not concerned with the immediate fuel shortages, but rather with long-term policies. The fuel crisis of a few weeks ago and the shortages of some forms of heat and power would, in my opinion, have occurred to a greater or less degree, whoever was at the helm—but I am seriously worried that the country has not been given the fullest information as to "why" the nationalization of the three industries—coal, gas and electricity, is to be brought about—what is the objective of the nationalizers and what advantages, if any, will accrue to the diverse users of fuel. There is something to be said for the view that public utilities should be owned or at least controlled by the nation. It is vitally necessary there should be a "policy" before it is in any way useful to evolve a "plan." I am sure we shall all agree that "good planning"—not "under planning" or "over planning" but "good planning" would be applauded by all—but there cannot be "good planning" unless there be a clear cut policy. You will already have realized that I have made a fundamental mistake in giving you as the title of this Address "Is there a Plan?" It should undoubtedly have been "Is there a Policy?" I have no hesitation in owning that I am a firm believer in the policy of co-ordination and integration for the coal, gas, and electrical industries.

They are a national service—a public utility, complementary, interdependent. Apart from this, they all depend on coal, the major natural resource in this country, on which our comfort—directly and indirectly—and our industrial stability depend. This invaluable national wealth cannot be replaced. It must be conserved. There is no alternative in sight that can replace it at the same cost. Atomic energy is never likely to replace coal as a general source of energy, and should never be taken into account in the formulation of a fuel policy. American statements about the immediate practicability of atomic generation might be written off as American exaggeration. It would be madness for the policy of the last 50 years to be continued when the success of any one of the industries was almost universally indicated by the extent to which it had increased its output or sales. This policy encouraged waste, and waste must be stopped. Better to look for lower sales at higher efficiency. Apart from this the different types of fuel in competition were each pushed by publicity and high pressure salesmanship—not always to the consumer's benefit—and certainly sometimes not for the national good. There are many cases where electricity is used when gas would have been better, and *vice-versa*.

A local authority owning one or other of these public utilities tends to enhance the progress of its own undertaking at the expense of the other utility which it does not own. New housing estates are being perverted to encourage exclusive use of one or other fuel. One might continue indefinitely with further reasons why the nationalization of the three industries could be justified—but all this presupposes that subject to the personnel of each of the industries operating under satisfactory conditions—the policy of the controlling body shall be:—

(i) To give all consumers freedom of choice as to the fuel and equipment they shall use.

(ii) The fuel shall be reliable—*i.e.*, satisfactory in quality and quantity.

(iii) To supply the fuel at the lowest price consistent with fair remuneration to workers and a fair return on the capital involved.

(iv) To see that the three industries are integrated and co-ordinated in their functions, not only among themselves but between the units of each industry.

This means that the fuel industry—consisting of all three—coal, gas, and electricity—should be *one* public service, with many activities in common—each being a department of one service.

A National Fuel Board

This brings me to my recommendation that the Ministry of Fuel and Power should bring into being a "National Fuel Board" at once. This Board should not be functional—*i.e.*, its members should not be responsible for any of the specialized departments but should have general control of policy only. It should consist of a Chairman, a Vice-Chairman and three or five further members of the Board—all chosen for their experience in administration with particular reference to the fuel industries and the requirements of fuel consumers. Technical men as such are not necessary unless they have outstanding qualifications as administrators, but a close knowledge of technical considerations would be of material advantage.

The Board would be responsible to the Minister and its first job would be to develop a "National Fuel Policy." The Chairmen of the coal, gas, and electricity boards, when formed, would attend—or even be members of the National Fuel Board itself.

The Board would have a secretarial staff and expert advice and reports could be called for from any direction, but the routine technical services of the staffs of each or all of the individual boards would be available to them. A Fuel Board or its equivalent, ought to have functioned long before any one of the three industries was nationalized. If that had been done the operations, structure, and functioning of the Coal Board would have been developed along the lines laid down in an approved National Fuel Policy and all they do would fall into its place in the National Plan. As two of the industries concerned have not yet been taken over, and one of them will not be touched—I am sure—for two or three years, it is highly probable that a considerable amount of confusion will be experienced after each has been taken over.

In any case many positions will have been prejudiced without reference to fuel policy as a whole.

The second duty of the board, in conformity with the original approved policy would be to lay down broadly the boundaries of each board's responsibilities and activities.

Division of Responsibilities

My experience of the fuel industries leads me to believe that some such division of responsibilities as follows would be nationally most convenient and efficient—:

(i) The Coal Board should be responsible for the production, preparation and sale of all coal raised in this country and all that goes with it.

(ii) The Electricity Board would be responsible for the production, distribution and sale of all electricity supplied from the grid with power to buy electricity when desirable. It would also be responsible for the supply and sale of electricity to individual consumers.

(iii) The Gas and Coke Board would be responsible for the production, distribution, preparation and sale of the public supply of gas, coke, and by-products. This would mean that the coke ovens now to be taken over by the Coal Board would come under the Gas Board. The Coke Oven Industry already provides the Gas Industry with over 12% of its gas requirements. It makes much coke for sale and tar and ammonia. The technique of the two industries is similar and the managers interchangeable.

* An Address to the North Western Fuel Luncheon Club.

To-day the Coal Board is developing its own administrative machine as rapidly as possible in order to function naturally so far as that Board is concerned, without any reference to what the position will be when the other two Boards are in being. Are we to assume that all the services of each of the Boards will then be in triplicate? That surely is unnecessary.

Why should there not be one costing and accountancy division in each region? This division would, as part of their job, issue combined accounts to individual consumers for their supplies of coal, gas, and electricity. The National Fuel Board's accountants at headquarters could ensure uniformity of method and accounting independent of each individual Board, while at the same time acting as a service department of each individual Board. There are many other directions in which the efficiency of administration of the three Boards and economy of organization can be improved with the appointment of a National Fuel Board.

It may be asked—where does the Ministry and that part of the Civil Service that has been so closely associated with the gas and electricity industries up to date come in. Up to the war very small efficient and knowledgeable staffs kept a close watch on the rights and obligations of individual supply undertakings. The Gas Industry was subject to much more rigid control than were electrical undertakings. Each of the large majority of gas undertakings had its own legislation. There were very many differences in the powers conferred. The Ministry of Health had to be satisfied that the amounts spent by municipal undertakings could be justified. The borrowing powers of gas companies were strictly limited. The quality and purity of the gas sold was strictly controlled as also was its pressure.

Presumably with nationalization, all this legislation will be done away with, and the consumers' interests will be watched either by the Gas Board or by the Ministry. If a Fuel Board be formed, this might come into the picture.

During the war the functioning of the Gas Divisions of the Ministry was necessarily very much expanded. It had greatly increased responsibilities. To assist in this connexion engineers and technical staffs were attached to the division. Under these extemporized conditions they have served the country well.

But—to my mind, the duties, other than those concerning the implementation of legislation should be eliminated as soon as a better alternative can be found. The training and experience of the Civil Service is not always suitable for the extra work that has been put upon them. It is not true that an "administrator" necessarily is capable of running an industry—especially among the juniors. It makes for delay and indecision—but rarely for mistakes, except those caused by delays.

When boards are formed all this industrial and technical responsibility should be taken from the Service. The electrical industry having for some years had its commissioners and Central Electricity Board has not been in quite the same position.

A Matter of Inevitability

I should like to say something concerning the proposed nationalization of the Gas Industry. In my view it is inevitable. As it is inevitable, is there nothing that can be done in the meantime to neutralize the condition of suspended animation? Even if the Ministry do not take action is there any possibility of the Industry itself doing all that is practicable to further the necessary co-ordination and integration?

I know that there are two main difficulties, first that the British Gas Council is a voluntary body and has no power to implement the decisions of the majority if individuals are recalcitrant. Secondly, the Ministry is very limited in its own powers and cannot direct undertakings to amalgamate or form district boards for instance. I hope that the Ministry will at an early date bring into being a knowledgeable but independent committee of individuals to report to him on the terms of the Bill and on the method of administration of the Industry. Should he by chance bring into being the Fuel Board—that could well serve the purpose.

However well the Coal Board may work, I am confident that it would be better that the Gas Industry should have a Board on quite different lines. I am sure that the Board should not be "functional." It should be the "policy-monger" and use its functional staff to advise it. Nor should there be a vertical set-up in the Gas Board.

The organization should commence at the regions; each region should have a general manager, and the usual staff of chief engineer, production engineer, technical director, distribution engineer, and accountant. They would form a staff meeting. Recommendations for changes and additions would be made by the general manager to headquarters where there would be a similar national staff. The proposals would be vetted by the appropriate officer and passed on to the Board. The regions would be autonomous as far as possible, subject to the broad national policy of the Board and to the general directions on methods of administration laid down by the national officers which had been agreed by the Board. Such an arrangement would eliminate overlapping, reduce numbers of personnel, encourage initiative, make it easier to cater for local requirements and idiosyncrasies of individual types of consumers, and reduce the sense of frustration and "pass to you" attitude of a highly regimented organization.

At the same time it would be better that the Industry (which has evolved in individual works to a high state of efficiency over a hundred years)—should not undergo revolutionary and sudden changes—particularly in personnel. The first job should be to adjust local deficiencies and make obvious advances within the regions—such as mutual help—common services, &c.

Many of us have been worried as to the future developments in fuel research—how shall it be administered—how sectionalized and who should have its ultimate direction? There is no more important phase of the fuel problem than this. What has been done under the guidance of the D.S.I.R. has been invaluable, by the development of the Fuel Research Board and the Research Associations attached to the Fuel Industries. But the lusty child has now grown up and there has been created a Ministry solely devoted to fuel. Surely the time has now come for all fuel research of a national nature to be transferred from the Lord President of the Council to the Ministry of Fuel and Power. I suggest that the present Fuel Research Board should be reconstituted and become the advisory co-ordinating body of all fuel research—completely financed by the fuel industries, and responsible to the Minister through the National Fuel Board which I have suggested should be set up. The Fuel Research Station should continue to be responsible to the Fuel Research Board and develop its present scope of work. The Gas Research Board which would be taken over by the Gas and Coke Board would become the Carbonization Research Board, acting for the gas and coking industries.

This would be particularly appropriate and useful should the coke ovens belonging to the Coal Board be transferred to the Gas and Coke Board as they undoubtedly should be (the B.C.U.R.A. has already passed to the Coal Board). Under a fully co-ordinated Fuel Board, B.C.U.R.A.'s scope of activity could with advantage be modified.

The Coke Research Association and that of the colliery owners have unquestionably been useful and their work must continue and be extended. It will be realized that under the new order there is room for a great deal of adjustment.

An Urgent Problem

Surely the Ministry responsible for fuel as a whole should control its own research and be responsible to Parliament for it. This matter is urgent. The Coal Board is in duty bound to carry out all the research it requires and will take over responsibilities which in the absence of a nationalized Gas Industry should in part be allotted to the Gas and Coke Board and the Carbonization Research Board. Here again is another important reason for the existence of a National Fuel Board.

I doubt whether legislation is required in the first instance, for the creation of such a Board as I have outlined. Its first duty is to elaborate a National Fuel Policy and if approved develop a plan to carry it out.

Until gas and electricity are nationalized they will deal with things as they are and the Ministry will call for the advice of the Board when dealing with technical and administrative questions coming within their jurisdiction.

I realize that details will have to be worked out. I realize too, there may be nothing original in some of my suggestions and that some may not be considered practicable. However that may be, I am as certain as night follows day that my earlier contentions are sound.

(i) That the fuel industries should be considered as one public service.
(ii) That a National Fuel Board is essential.
(iii) That National Fuel Research should be transferred to the Ministry of Fuel and Power.
(iv) That coke ovens taken over by the Coal Board should become part of the Gas and Coke Board.

C

DEVELOPMENT IN THE THEORY OF COAL SAMPLING

By E. H. M. BADGER

An account is here given of some of the work on the fundamentals of coal sampling carried out in the last twelve years, in particular that of B. A. Landry. Landry has shown that the number of increments required for a given accuracy is dependent on the degree of mixing of the coal, the weight of increment, the weighted average weight of the individual coal pieces, and the ash in the coal. In the B.S. specifications the number of increments is only explicitly related to the ash in the coal. If Landry's formula is applicable to British coals, then the Author of this article maintains that on the B.S. specifications large coals and coals whose sizes are near the top of each size grade are undersampled.

B. A. LANDRY, in his "Fundamentals of Coal Sampling" (U.S. Dept. of Interior, Bureau of Mines, Bull. 454, 1944), has made a notable contribution to a rather difficult subject. His treatment is highly original in several respects and is set out extremely clearly. It is proposed in this article to give some account of his work and to see how his conclusions affect the B.S. specifications, which are largely due to E. S. Grumell and S. C. Dunningham (B.S. 403, 502, 735, 763, 1017, &c.). Some of the work of L. A. Bushell (J. Inst. Fuel **10** (1936-37) 384) and A. B. Manning (J. Inst. Fuel **9** (1935), 132) will also be discussed.

Since nearly all writers on coal sampling make use of a certain amount of statistical theory but often use different terms it is important to be clear about their meaning. In this article consideration will be given only to the ash in the coal and to assume that this is the attribute of the main body of the coal about which it is desired to obtain information by sampling. For the purpose of illustrating the statistical terms, the determined ash in each of a large number of individual increments may be considered. The mean ash of all the increments may be computed and the difference between each individual determination and the mean noted. The "average error" is then the sum of all the deviations from the mean, irrespective of sign, divided by the total number of increments. The square of the "standard deviation" is the sum of the squares of the deviations divided by the total number. The relation between average error and standard deviation varies in each particular case, but the average error is usually about 0.8 times the standard deviation. Average error is used in the B.S. specifications and by Bushell, but is objectionable from a mathematical standpoint and should be replaced by the standard deviation. Probable error will not be used in the article.

Standard deviation and average error are measures of the variation of samples among themselves. It will be necessary to distinguish carefully the following:

(1) The standard deviation of gross samples composed of N increments, designated by S_{NW}

(2) The standard deviation of the individual increments of weight W, designated by S_W

(3) The standard deviation of the individual pieces of coal, of weight w, designated by S_w

Standard Deviation of the Gross Sample

The object of coal sampling specifications is to produce a gross sample such that its standard deviation is of an acceptable value. Thus, if (as in the B.S. specifications) it is desired that in the long run 99 gross samples out of a hundred should give an ash content differing from the true value by not more than $\pm 1\%$, then it is a simple mathematical fact that $S_{NW} = 0.3882$, or $S^2_{NW} = 0.1507$. The composition of a gross sample which is satisfactory can then be determined if the following questions are answered:

(1) How is S_{NW} related to S_W?

(2) How is S_W related to S_w?

(3) How is the value of S_w determined?

It is a well known theorem in statistics that if the standard deviation of single pieces is S, that of groups of N pieces is $\frac{S}{\sqrt{N}}$ provided that the pieces are distributed at random. Therefore if the increments are taken at random the relation will be $S^2_{NW} = S^2_W/N$. "Taken at random" means that any one piece of coal in the consignment is just as likely to be included in the gross sample as any other piece of coal. In practice this is not the case, as samples are usually taken at regular intervals. This is not random sampling but orderly sampling. Landry has given the mathematics of orderly sampling. When the increments are taken at random the number needed for a given accuracy is independent of the total quantity sampled, but the number of orderly samples required, on the other hand, is dependent on the quantity sampled. When the total amount of coal is large the number of random and of orderly samples required are the same, but for smaller quantities of coal fewer orderly samples are required than random samples. The order of difference may be illustrated as follows:

Wt. of coal sampled	Random	Orderly
1 ton	35	28.5
10 tons	35	33.7
100 tons	35	34.5

Therefore if orderly samples are treated as if they were random samples an increased accuracy will result with the advantage that the mathematics are easier to handle. The writers considered in this article all treat the problem in the same way and all are agreed that the relation between the standard deviation of gross samples containing N increments of weight W and that of the individual increments is

$$S^2_{NW} = \frac{S^2_W}{N}$$

Standard Deviation of Individual Increments

It has been explained that the standard deviation of the gross samples, S_{NW}, is fixed simply by the degree of accuracy required. Therefore by making use of the formula

$$N = \frac{S^2_W}{S^2_{NW}}$$

the number of increments required to give an acceptable degree of accuracy can be calculated if the standard deviation of the individual increments, S_W, is known.

It is clear from the writings of Grumell and Dunningham that they regard the standard deviation or average error of the increments as a characteristic of the coal which is independent of the size of the increment, provided that it is not too small. Thus in B.S. 403, p. 34, it is stated that for slack up to 1 in. in size the same average error holds for 2 lb. and for 5 lb. increments. In B.S. 502, p. 22, which deals with larger coals, the average errors of 10 lb. and of 26 lb. increments are said to be "almost identical." Actually in each case the larger increment has the smaller average error, but the authors evidently regard the differences as being insignificant. They regard the average error of the increments as being a function of the ash content (B.S. 403, p. 45). For a given size of coal they specify that the weight of each increment must exceed a certain minimum value, which is based on the "size weight ratio." This term was introduced by E. G. Bailey in 1909 (Ind. Eng. Chem., Vol. 1, p. 161) and may be defined as

$$\text{S.W.R.} = \frac{\text{Mean weight of largest dirt particles} \times 100}{\text{Weight of sample}}$$

A great deal of work has been done relating the size weight ratio to the maximum error encountered (say) in 100 analyses. Credit must be given to Bailey for being the first to try to put coal sampling on a scientific basis, but it is felt by the writer that the use of the size weight ratio has tended to obscure the relation between the standard deviation of increments and the number of particles contained in them. A logical method of coal sampling can be built up without its use.

Bushell (J. Inst. Fuel **10** (1936-37) 384) pointed out that the average error of increments was likely to depend on their size. He investigated South African coals by taking increments of different sizes and analysing individually 100 increments of each size. This was done for several different coals. Thus for a ¼ in.-1 in. nut coal he obtained the following results:

Weight of increment	Average error
¼ lb.	2.51
2 lb.	1.26
3 lb.	1.12
5 lb.	1.03

He did not obtain a very good correlation between the average error and the ash, but found better agreement when the ash was replaced by a factor derived from float-and-sink data, defined as follows:

Let X% of the coal sink at sp. gr. 1.6,
Let A% be the ash in this fraction,
Then (100—X)% floats at sp. gr. 1.6,
Let $\frac{Y \times (100—X)}{100}$% sink at 1.3 but float at 1.6,
Let $\frac{AX}{Y} = f$,

Then Average error = 0.16f for coal below 1½ in.
= 0.36f for coal above 1½ in.

While Bushell's work is an advance on that of Grumell and Dunningham it is still largely empirical. The true significance of Bushell's results has been pointed out by Landry, who has used them in a most lucid manner to illustrate a conception of very great importance.

This conception is that whereas the *increments* in the gross sample may be regarded as being taken at random, the distribution of the *individual pieces* of coal is not necessarily random. He considers the coal lying in the coal bed and suggests that there may be a gradual change in the ash content from one part of the bed to another. He calls such a coal highly segregated. In such a segregated coal there will be a high probability that the ash content of neighbouring pieces is almost the same. If this is so, then the ash content of an increment containing p pieces will be the same as that of the individual pieces themselves. Hence $S^2_W = S^2_w$.

On the other hand, if the coal is completely mixed each increment will contain coal of widely differing ash content so that there will be less variation in the ash content of the increments than of the individual pieces. For increments containing p pieces the relation between the standard deviations of increments and pieces will be

$$S^2_W = \frac{S^2_w}{p}$$

For a uniform size coal, $p = \frac{W}{w}$, where W is the weight of the increment and w the weight of the individual pieces. For a non-uniform size coal Landry shows that w can be replaced by a weighted average, $\overline{w}$, which is the sum of the squares of the weights of the individual pieces, divided by the total weight. This quantity can be obtained graphically from the screening analysis, or from the Rosin Rammler equation.

In the ordinary way there will doubtless be some mixing in taking the coal from the bed to the point of sampling, but this will be by no means necessarily complete, unless, perhaps, the coal has been washed. The way to find out the degree of mixing is actually to measure the standard deviation of different sizes of increment. The relation between S^2_W and S^2_w can be written

$$S^2_W = S^2_w \left(\frac{W}{w}\right)^{a-1}$$

where (a) is a function of the correlation between the ash of neighbouring pieces. If there is no mixing, $(a) = 1$ and hence

$$S^2_W = S^2_w$$

If there is complete mixing, $(a) = 0$ and hence

$$S^2_W = S^2_w \left(\frac{W}{w}\right)^{-1}$$

If there is partial mixing, (a) will lie between 0 and 1.

Landry took Bushell's figures for the ash analysis of individual increments and worked out the standard deviations. (He does not use average error.) These were as follows:

Weight of increment	S^2_W
¼ lb.	11.889
2 lb.	2.822
3 lb.	2.111

When S^2_W is plotted against W on log-log paper, a straight line of slope —0.69 is obtained. Hence $(a) = 0.31$, *i.e.*, mixing is by no means complete. The average weight of a single piece of this coal was 0.0265 lb., corresponding to $S^2_W = 56$. From this point on the graph lines have been drawn showing the relation between S^2_W and W, (1) if there had been no mixing, (2) if there had been complete mixing, and (3) the partial mixing observed in Bushell's experiments (Fig. 1).

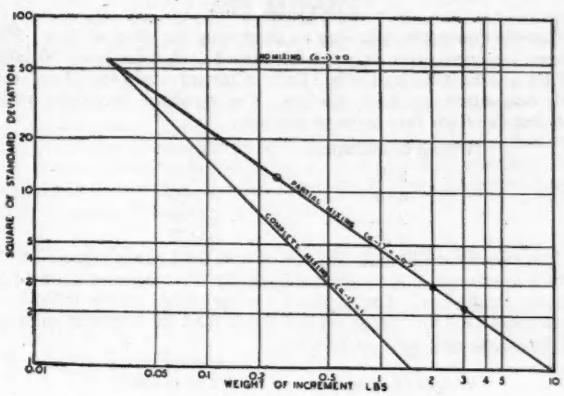


FIG. 1

If there had been complete mixing, the relation between S^2_W and W would have been as follows:

Weight of increment	S^2_W
¼ lb.	5.926
2 lb.	0.741
3 lb.	0.494

Because a 2 lb. increment contains eight times as many pieces as a ¼ lb. increment, S^2_W for 2 lb. increments is ⅛ that for ¼ lb. increments when there is complete mixing. For the incomplete mixing which Bushell found, S^2_W for 2 lb. increments was $8^{-0.69} = \frac{1}{4.2}$ times that for the ¼ lb. increments. The importance of the degree of mixing is thus apparent.

Landry found that unwashed American coals also gave a line of slope about —0.7. For washed coals the slope was nearly —1, indicating a high degree of mixing.

Manning (*loc. cit.*), who wrote some years before Landry, has also tried to put the theory of coal sampling on a more scientific basis. Starting from the standard deviation of single pieces (leaving for the moment how he calculates this) he works out the weight of gross sample required. He gives the relation, for a uniform size coal,* between the standard deviation of gross samples and individual pieces as

$$S^2_{NW} = \frac{S^2_W}{n}$$

where n is the total number of pieces of coal in the gross sample. Since S^2_{NW} is determined only by the degree of accuracy required and S^2_W has been calculated from the characteristics of the coal, n is determined. The weight of gross sample required is obtained by multiplying n by the weight of the individual pieces of coal.

Manning does not consider the weight and number of increments at all, but goes straight from the individual coal particles to the gross sample. Thus according to this method of calculation 10 increments of 5 lb. should give the same accuracy as 25 increments of 2 lb., although Grumell and Dunningham (B.S. 403, p.37-38) have shown that this is not true. From the form of Manning's equation it is obvious that he has assumed that all the coal particles are distributed at random. It is easy to see that his formula becomes equivalent to Landry's, if $(a) = 0$. If $(a) = 0$, Landry's formula is

$$S^2_{NW} = \frac{S^2_W}{N} = \frac{S^2_w \left(\frac{W}{w}\right)^{-1}}{N} = \frac{S^2_w}{pN}$$

* For non-uniform size coal Manning uses the same weighted average weight as Landry, though he does not express it in the same form.

Now N is the number of increments and p is the number of pieces of coal per increment, therefore pN is the number of pieces in the gross sample. Therefore the formula is the same as Manning's only when there is complete mixing of the pieces of coal. Landry has shown by experiment that this in general is not true, but is approximately true for washed coals.

Effect of Bias

Landry quotes the following as illustrating the effect of bias. 200 increments were taken of a 0-2 in. washed coal, there being 50 each of 1 lb., 2 lb., 4 lb., and 8 lb. Each increment was screened and the ash determined on each fraction. The standard deviations were worked out from the results as follows :

Weight of increment	S_W^2
8 lb.	0.1895
4 lb.	0.3706
2 lb.	0.9669
1 lb.	0.6577

The values for 8 lb. and 4 lb. lay on a straight line of slope —0.97 which is reasonable for a washed coal, but the other two points did not lie on the line. The weighted average weight of the individual pieces was 0.031 lb. Those actually found from the screening analysis of the increments were as follows:

Weight of increment	Average weight of pieces
8 lb.	0.031 lb.
4 lb.	0.029 lb.
2 lb.	0.030 lb.
1 lb.	0.015 lb.

The value for the 1 lb. increment was much too low, showing that not enough large coal had been collected. The weight composition of the 2 lb. increment was correct but there had been a selective action resulting in a change of slope from — 0.97 to — 0.87 (Fig. 2). This shows the danger of having the weight of the increment too small. The 1 lb. samples were not representative of the weight composition of the coal, and the 2 lb. samples showed some segregation. Landry is not very clear as to how big he thinks the increments ought to be, but he evidently regards the weights specified by the A.S.T.M. as being too low (p. 77).

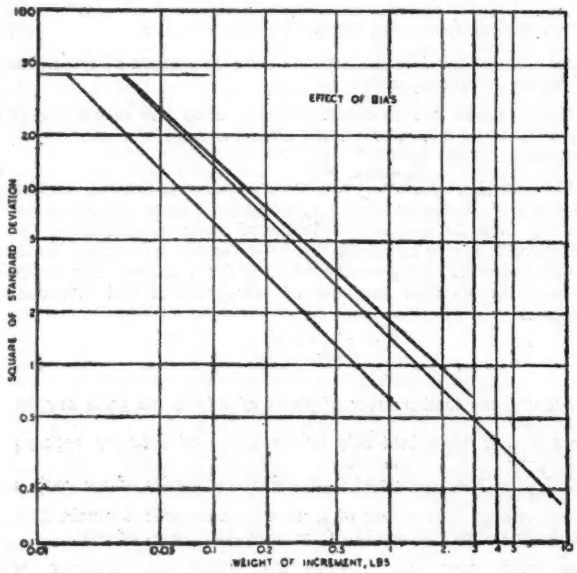


FIG. 2

Standard Deviation of the Individual Pieces

Landry's equation

$$S_W^2 = S_w^2 \left(\frac{W}{w}\right)^{a-1}$$

gives the standard deviation of the increments in terms of their weight, the average weight of the coal pieces, the degree of mixing, and the standard deviation of the pieces.

The most direct way of determining the standard deviation of the pieces is to find the ash content of a large number of separate pieces. This was done by Morrow and Proctor (Am. Inst. Min. and Met. Eng. Tech. Pub. 645, Feb., 1935) for three size ranges of coal.

Size range in.	Average weight of piece lb.	S_w^2	Average ash %
2 by 4	0.664	31.05	6.7
1 by 2	0.083	52.60	8.0
½ by 1	0.0104	110.3	9.4

The results are plotted in Fig. 3 in which the points lie on a straight line of approximate slope — 0.306. This slope is less than that for *increments* of different weight and shows, as would be expected, that there is less heterogeneity in the coal bed itself than among the pieces forming an increment at the point of sampling. A less tedious way of obtaining S_w^2 is to collect pieces of the same size and to divide them into fractions of different specific gravity. The weight of each fraction and the ash percentage in each can then be determined. A curve can then be drawn showing the cumulative weight percent. which has an ash content below a given value (Fig. 4). S_w^2 can then be computed by taking the ash percentages corresponding to a large number of equal intervals along the weight scale.

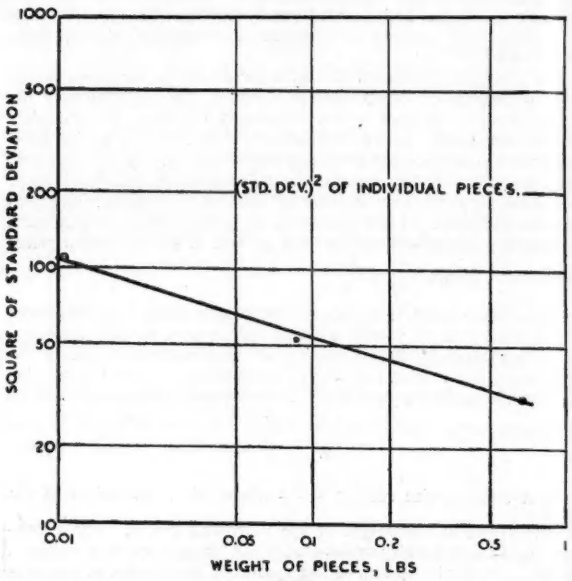


FIG. 3

Landry examined a large number of American coals taking some of different size range from each of several sources and computed S_w^2 for each. He found that S_w^2 was a function not only of the weight of the coal pieces but also of the ash. He expresses this result by the equation

$$S_w^2 = Z_w (y - 4)$$

where Z_w is a function of the weight of the pieces and y is the average ash content. Of the ash, 4% is regarded as being inherent in the coal and evenly distributed. Fig. 5 shows the plot of Z_w against w. It will be noted that there is a sharp break in the slope at a value of w = 1.8 lb., which indicates that large pieces of the coals examined were more heterogeneous than small pieces. It is not certain whether this change of slope at 1.8 lb. is a general phenomenon.

It should be realized that the relation deduced for S_w^2 is an empirical one for American coals and may not apply exactly to British coals.

Manning has attempted to calculate S_w^2 from the properties of the coal. He regards the coal as being composed of two or at the most three different kinds of particle only, which have the same composition irrespective of their size. These are (1) coal with very little ash, (2) dirt consisting mostly of ash, and (3) "middlings." He regards these particles as being completely mixed and treats the problem of calculating S_w^2 as if it was a question of drawing different coloured balls out of a bag containing a large number. On these assumptions he is able to deduce an expression for the standard deviation of the ash in terms of (1) the proportion by number of each kind of particle, (2) the ash content of each, and (3) the density of each.

There is little doubt that this treatment is unsatisfactory. From the practical point of view the required weights of gross sample vary very much according to the composition assigned to the various particles. Thus for a coal containing 10% of ash and consisting of

pieces all 1 in. in size he obtained the following weight of gross sample required such that 99 gross samples out of 100 would give an ash content within ±1% of the true value.

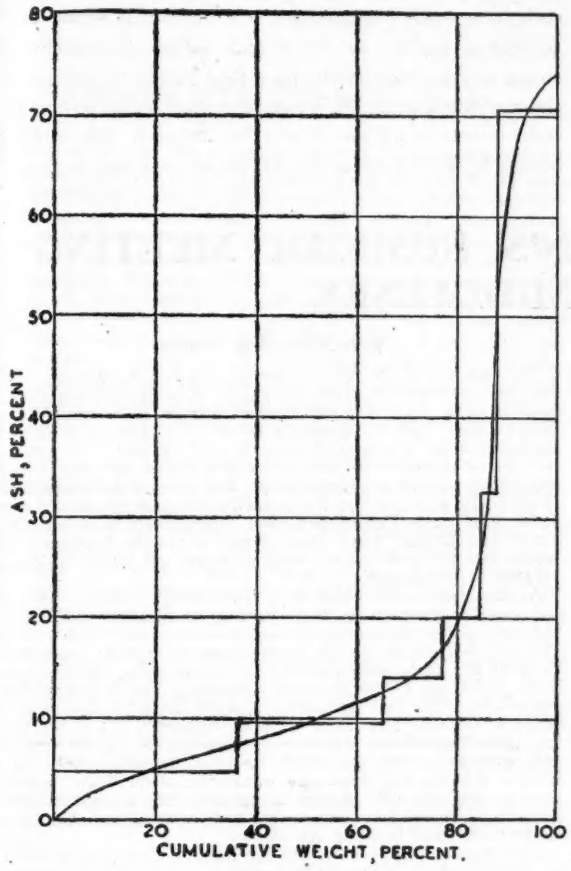


FIG. 4

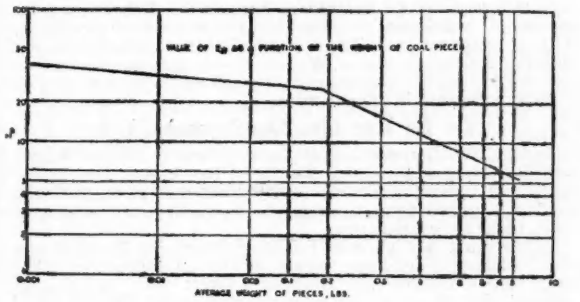


FIG. 5

Composition	Density	% Ash	S^2_w	Weight of gross sample, lb.
80.1% coal	1.3	1.7	351	58
19.9% dirt	1.9	43.4		
80.1% coal	1.3	1.7	468	77
8.5% middlings ...	1.5	10.8		
11.4% dirt	2.2	67.6		
88.6% coal	1.32	2.6	646	107
11.4% dirt	2.2	67.7		
90.0% coal	1.3	Nil	1,510	249
10.0% ash	2.4	100		

Consideration will show that some of Manning's assumptions are open to question. In the first place float-and-sink tests show that the coal cannot be divided into two or three sharply defined fractions of widely differing properties. In practice a smoother distribution of ash contents will be observed and hence S^2_w will be lower than that calculated by Manning because those particles with an ash near the mean will contribute little to S^2_w. Secondly, in Manning's example the calculation would have been exactly the same if all the pieces had been ¼ in. or ½ in. instead of 1 in. This amounts to assuming perfect homogeneity in the pieces—*i.e.*, that a piece of coal breaks up into smaller portions of exactly the same ash content. Landry has shown, however, that this is not usually true but that small pieces show a bigger variation in ash content than the large ones from which they are derived. Thirdly, Manning assumes that the whole of the coal pieces can be regarded as being distributed at random. Landry has shown that this assumption is not justified, except perhaps for washed coals, and inspection of Grumell and Dunningham's figures and, of course, Bushell's, confirm this.

Comparison of Landry's Formula with the B.S. Specifications

The number of increments required for a given accuracy can now be calculated by making use of Landry's work. It has already been shown that in order that 99 results out of 100 shall be within ±1% of the true value:

$$S^2_{NW} = 0.1507.$$

Therefore we can write

$$N = \frac{Z_w (y-4) \left(\frac{W}{w}\right)^{-0.7}}{0.1507}$$

It will be noted that for a given accuracy N is a function not only of the ash in the coal but also of the average weight of the coal pieces and of the weight of increment chosen. The B.S. specification, on the other hand, relates the number of increments only to the ash in the coal, except for the proviso that the weight of increment must exceed a certain minimum corresponding to the size of the coal. The weight of increment and the average weight of the coal pieces do not enter explicitly into the calculation.

It is interesting to compare the number of increments required by Landry's formula and those from the B.S. specification 1017. The percentage ash in the coal will be taken to be 10% and the accuracy the usual ±1%, 99 times in 100. The weight of increment will be that recommended in B.S. 1017.

Size of coal	Av. wt. of pieces, w. lb.	Increment W lb.	$\left(\frac{W}{w}\right)^{-1}$	$\left(\frac{W}{w}\right)^{-0.7}$	Z_w	N	B.S.S.
0-3 in.	0.092	6	0.0155	0.053	26.5	56	24
0-2 in.	0.031	4	0.0077	0.033	29	38	24
0-1½ in.	0.0145	3	0.0048	0.0235	30.5	29	24
0-1 in.	0.0047	2	0.0023	0.0145	33	19	24
0-½ in.	0.0006	1	0.0006	0.0055	40	9	24
1¼-2 in.	0.107	4	0.0267	0.077	26.2	81	24
¾-1 in.	0.025	2	0.0125	0.0455	29	53	24

If Landry's formula can be applied to British coals, then on the B.S. method the larger coal is badly undersampled. The effect of the weighted average weight, $\overline{w}$, is shown by comparing the number of increments for a 0-1 in. coal and for a ¾-1 in. coal. On the B.S. method the number is 24 for each, but Landry's formula gives 19 and S3 respectively. The reason for the difference is, of course, that the closer graded coal contains fewer particles per increment.

The difference between complete and partial mixing is shown by comparing $\left(\frac{W}{w}\right)^{-1}$ with $\left(\frac{W}{w}\right)^{-0.7}$. For a 0-3 in. coal, sampled by 6 lb. increments, the ratio is about 3—*i.e.*, if complete mixing were assumed only 19 increments would be required instead of 56.

Landry's work is undoubtedly of great importance and the scientific clarity with which he presents the problem and in particular his treatment of the degree of mixing in the coal are of the highest value. In order to determine whether the mixing exponent of 0.7 applies to British practice, experiments like those of Bushell on the standard deviations of different weights of increment should be conducted. It is probable that sea-borne coal is more mixed than rail-borne. Incomplete mixing is implied in the statement of Grumell and Dunningham (B.S. 403, p. 43) that "the accuracy of the sample depends not so much on the total weight of sample as on the number of increments." This statement may be illustrated by Bushell's results. From the standard deviations derived from his data it may be shown that the number of increments required so that 99 gross samples out of 100 give a result within ±1% of the true value is as follows:

Weight of increment	No. of increments	Weight of gross sample
¼ lb.	79	19¾ lb.
2 lb.	19	38 lb.
3 lb.	14	42 lb.

On Manning's theory, which implies complete mixing, the weight of gross sample would have been the same in each case and the number of increments would have been inversely proportional to the weight of the increments. Thus 10 2 lb. samples or 7 3 lb. samples would give the same accuracy as 79 ¼ lb. samples, making a gross sample of about 20 lb. each time. But the effect of incomplete mixing is to raise the number of 2 and 3 lb. samples required to 19 and 14 respectively so that as the weight of increment increases the weight of gross sample also increases. Therefore if the weight of gross sample was kept at 20 lb. in each case, the accuracy would diminish as the weight of increment was increased and it would be correct to state that, for the same weight of gross sample, it would be preferable to have a large number of small increments.

The most doubtful element in Landry's formula for the number of increments required is the use of $Z_w (y - 4)$ for S^2_w. He points out that it is only strictly applicable as a median compromise to the coals from which the expression was derived. It should not be accepted as applying to British coals without investigation. S^2_w should be determined directly for a large number of different coals either by measuring the ash in individual pieces of coal or from float-and-sink tests in the way Landry has indicated. The correlation between S^2_w and the size of coal and the ash could then be found.

SOUTHERN ASSOCIATION'S SUMMER MEETING IN NORTH MIDDLESEX

"INSTITUTION weather" favoured the Summer Meeting of the Southern Association of Gas Engineers and Managers on June 26, when members, ladies, and visitors numbering close on 200 were the guests of the North Middlesex Gas Company, of which Mr. Frank Dawson, President for 1946-47, is Engineer and Manager. The morning was spent in visiting the Company's works at Mill Hill and the head offices at Regent's Park Road, Finchley, the two parties re-joining for luncheon as the guests of the Chairman and Directors of the Company at the Hendon Hall Hotel.

In the afternoon there was a choice of three visits: (a) The testing station of the Fire Offices Committee Fire Protection Association; (b) the aluminium piston factory of Specialloids, Ltd.; and (c) the research laboratories of De La Rue Gas Development, Ltd., all at Boreham Wood, Elstree, and all in the area of the Watford and St. Albans Gas Company. The three parties re-assembled at the Hendon Hall Hotel for tea.

Mr. **A. E. Sylvester,** Chairman of the Company, presided at the luncheon, supported by Major G. Lloyd George, Mr. F. M. Birks, and Mr. J. H. Dyde, three of his fellow Directors, and the guests included Alderman W. R. Clemens, Mayor of Hendon, Councillor Norman, Mayor of Finchley, and several of the Local Government officials of both Boroughs. On behalf of his colleagues on the Board, Mr. Sylvester extended a cordial welcome to the members of the Association, their ladies, and the civic heads of the two Boroughs.

The **President** (Mr. F. Dawson) proposed the only toast—that of the visitors—and expressed appreciation of the generous hospitality extended to the Association by the Directors and of their personal support during his year of office as President. He coupled with the toast the name of the Mayor of Hendon, who had a long and distinguished record of public service not only in his own Borough but in the County of Middlesex where, during the latter part of the war, he was for three years Chairman of the Finance Committee. He also especially welcomed the Mayor of Finchley, the Chairman of the Finchley Housing Committee, and principal officials from both Boroughs; Mr. G. le B. Diamond, Regional Controller for the South-East Region; Colonel H. C. Smith, Chairman of the British Gas Council; Mr. J. R. W. Alexander, General Manager of the British Gas Council; Dr. W. T. K. Braunholtz, Secretary of the Institution of Gas Engineers; Dr. A. B. Badger, Manager of the Federation of Gas Employers; Mr. W. H. Tuckey, Director of the Fire Offices Committee Fire Protection Association; Mr. Leopold Friedman, Director of De La Rue Gas Development, Ltd.; and a large number of other guests.

Alderman **W. R. Clemens,** Mayor of Hendon, in a witty reply, questioned whether the Gas Light and Coke Company or the North Middlesex Gas Company made the better gas; at any rate he had felt during the crisis that the North Middlesex pressure was the better of the two. Such functions as that were the spice of life to those engaged in local government work. He had just returned from Torquay, where he had attended a meeting at the ratepayers' expenses, and through his membership of the Middlesex Education Committee he was interested in no fewer than 32 conferences fixed for this summer, to which 150 people could go at the ratepayers' expenses, and the same persons could go each time if they so desired. He expressed some misgivings as to the future control of the Industry, but hoped that it would be realized "at the top" that the best way was to let the people who knew their job run it in the appropriate way. Whatever happened, the Gas Industry would have to go forward, and he believed they would continue to do their best for the community. They would find in his wife a very fine propagandist for gas; she swore by gas for cooking and for refrigeration. An electric refrigerator in his flat had been out of order ever since March of last year.

The Mill Hill Works

The capacity of the retort house at Mill Hill is 3¼ million cu.ft. per day. The present plant was put to work in 1936 and the first beds to go to work are being re-set for the first time this year after 11 years' almost continuous work. The four existing water gas plants have a combined capacity of 3,550,000 cu.ft. per day, and the programme for the immediate future provides for the installation of a 2¼ million cu.ft. per day fully automatic set, with all ancillary plant, on the site formerly occupied by the old retort house now being demolished, and where there is room for a second similar set. The combined capacity of the three main gasholders is 4,225,000 cu.ft., with a water gas relief holder of 212,000 cu.ft. capacity.

At the head office the most interesting feature was the "Hollerith" punched card accounting installation installed last October, a full description of which was given by Mr. J. D. Thomas, Accountant, in his recent Paper to the Eastern District. Each of the three sales and service districts has within its area from 11,000 to 15,000 domestic consumers and is staffed by a group of people who operate as a team having a district representative to cover each 5,000 of these consumers. A district clerk forms the link between the district representative, district foreman, and showroom personnel, and the office accommodation is so laid out that the first three mentioned units of the team are seated together and thus able to meet and discuss their mutual problems. A special section of the department deals with all industrial, commercial, and new building installations.

The training of gas fitters for the London district examinations is undertaken in the industrial workshop of the Company at Regent's Park Road, and the gas fitting apprentices attend one day each week at the Tottenham Technical College a progressive course of instruction for the City and Guilds of London Gas Fitting Examinations. These apprentices soon after recruitment undergo a selection test at Watson House and, dependent on this and the willingness and aptitude shown during work and at school, an apprenticeship is offered them.

De La Rue Gas Development, Ltd.

During the afternoon one of the visits was to the new Research and Development Section at Elstree of De La Rue Gas Development, Ltd., where a thoroughly enjoyable tour of inspection was made and new designs of water heaters, cookers, and refrigerators were there for examination.

At the outset Mr. Leopold Friedman, Managing Director, gave a short address of welcome, suggesting that in the course of three years the Company had achieved a great deal, but this only marked the beginning of greater achievement. Mr. R. B. W. Thompson, of the Ministry of Supply, also spoke, remarking that the Ministry was keenly interested in the progress of De La Rue, as, indeed, was evidenced by the opening of the firm's factory at the Team Valley Estate by the Minister, Mr. Wilmot. De La Rue, he said, was an energetic and confident organization, and the name of Leopold Friedman stood high in the Gas Industry. At the conclusion of the visit thanks on behalf of the visitors was voiced by Mr. Dyde.

Specialloids, Ltd.

At the works of Specialloids, Ltd., the visitors saw the complete process of aluminium piston manufacture under the most modern conditions—the testing of metals, casting, pressing, machining, finishing, and the final inspection and testing of the finished products. Wide variations in types and demand call for considerable flexibility in the manufacturing system, and the methods by which these requirements are met were of absorbing interest. Gas is very largely used throughout the works as the heating medium. After tea and biscuits, the President briefly thanked Mr. E. D. Graham, Technical Director, for arranging the visit and thus contributing so substantially to the day's pleasure.

ELECTRICITY IN THE GAS INDUSTRY*

By G. M. RIMMER, A.M.I.E.E., M.American I.E.E.
Electrical Engineer, City of Birmingham Gas Department

(*Continued from p. 725, Vol. 250*)

Utilization of Electricity on Gas-Works

(A) Efficiency and Costs

FEW mechanical drives can be designed with the full knowledge that assumed operating conditions will prevail in practice, and, in fact, cases can be quoted where calculated powers have been over-estimated by as much as 100% and underestimated by about 50%. Again, operating load factors are liable to considerable variation over a period of 24 hours, and it becomes very obvious that long-term operating efficiencies will be very low unless the motive machine has a wide power range in the neighbourhood of maximum efficiency. The electric drive is superior to every form of drive in this respect; furthermore, electric motors have maximum efficiencies which vary very little with rating: on the other hand, small steam engines operating at varying loads are extremely inefficient, particularly when non-condensing. Transmission losses for steam are considerably higher than for electricity, and in first cost the electric drive is most favourable.

(B) Scope of the Electric Drive

The gas engineer may now be wondering how far electrification can be pursued to advantage on an existing station, and in this respect no general rule can be given. Only careful examination of all the factors involved (*i.e.*, fuel costs, labour charges, outstanding capital, &c.), will provide the answer. There can be no doubt, however, that this policy will bear much fruit if applied to existing drives which are extravagant steam users, *i.e.*, small and scattered turbines and engines which have to cope with variable loads. The limits to this scheme are chiefly mechanical, being concerned with speeds and actual mechanical details.

If, however, the prospect is one of complete electrification, as in the case of a new station, all mechanical considerations must at the outset be made subordinate to the electrical installation, whence the ideal scheme of running a whole works on waste heat alone can be achieved.

The following are some of the conversions that have already been carried out with a view to reducing steam consumption and operating costs:

(*a*) A 4 million cu.ft. per hour booster station was powered by steam drive consisting of one 430 h.p. and two 65 h.p. turbines, the running speeds being approximately 5,000 and 1,650 r.p.m., respectively: steam consumption was 21.5 million lb. per annum, the cost of which amounted to more than £5,000. Steam was obtained from a nearby electric power station, and because of modifications which were to be undertaken at this station continuity of steam supply was very doubtful except at high pressures which would have been unsatisfactory for the booster plant. The alternatives were, to install suitable steam-raising plant utilizing dust-burning boilers of the chain-grate stoker type, or to convert the two smaller boosters to electric drive and replace the large booster so as to operate at a speed within the range of D.C. electric motors. The capital costs of the two schemes were of the order of 2.5: 1 in favour of the electric drive, and the estimated running costs about 2: 1, also in favour of the electric drive; it was therefore decided to electrify this booster station.

Briefly, the two small boosters were converted to electric drive by means of D.C. compensated motors having a speed range of from 750 to 2,000 r.p.m., with a maximum continuous output of 110 h.p., an overload capacity of 20% for a period of 2 hours, and a maximum efficiency of 94%: the large booster has a 460 h.p. D.C. compensated motor of similar type, with a speed range of 750 to 1,500 r.p.m.

High-tension electric supply at 11,000 volts was selected as the most suitable incoming voltage, and two separate feeders direct from the public power station bus-bars were installed: this electric supply was transformed to 1,000 volts A.C. (six-phase), and thence by glass-bulb rectifiers to 560 volts D.C.

The electrical plant was divided into two units, each being capable of carrying 75% of the total load of the booster station, and facilities for parallel operation of the four rectifiers on the D.C. side were provided with a view to increasing reliability, many small items such as forced-draught fans for the motors being duplicated. The plant has been running for about nine months, giving every satisfaction. The running costs have been considerably less than estimated, being in the neighbourhood of £1,000 per annum. The method of working has been so arranged that maximum efficiency can be obtained from each machine: thus, from 6 to 11 a.m., one small booster is in operation; from 11 a.m. to 2 p.m., two boosters are in operation; and from 2 p.m. onwards the plant is again reduced to one small booster. The Sunday peak load is accommodated by the one large booster for a period of about 2 hours only, and during the rest of the week this large machine is acting as stand-by in case of failure of the small machines.

(*b*) A second, smaller booster station incorporating two 600,000 and one 400,000 cu.ft. per hour capacity boosters was operated by steam turbine, steam being raised on site, from coke fuel, by means of hand-fired boilers. The expenditure involved in this conversion was in the neighbourhood of £1,500 only, and operating costs were reduced by approximately £1,500 per annum.

Initially, the machines were being operated by variable-speed turbines, governors being provided on the outlet side of the boosters; with A.C. motors it was necessary to run at a constant speed of 3,000 r.p.m., utilizing the outlet governors for pressure control, and it was felt that this might impair the efficiency. Experience has, however, proven that assumption to have been wrong, and the actual efficiency obtained has been considerably higher than that of the steam-driven turbines. High-tension public supply was not available on this site, and with the goodwill of the Birmingham Corporation Electric Supply Department, Star-Delta A.C. motors of 45 and 25 h.p. were installed at 400 volts.

(*c*) Several steam-driven blowers on a water-gas plant were investigated, and it was estimated that three 90 h.p. blowers were absorbing anything from 5,000 to 10,000 lb. of steam per hour, according to conditions of working. This represents a steam consumption of about 40 lb. per b.h.p. per hour, a further 30 h.p. being required for condensing plant circulating water. There can be no doubt that this high consumption is due to the low load factors caused by the intermittent nature of the drive, and it was estimated that, by electrification, steam consumption could be reduced to less than 12 lb. per b.h.p., condensing facilities being unnecessary. Further, the intermittent demand can be met with very little loss from the electric motor drive, and the low load factor will not reduce the maximum efficiency by more than 10%. Thus we have an estimated steam saving of about 25 lb. per b.h.p. per hour, which represents about 100 tons of steam per b.h.p. per annum, and, with an average load of 150 h.p. represents a fuel saving of about 3,000 tons per annum.

Safety Precautions

(A) General to Gas-works Conditions

Too much emphasis cannot be placed upon this subject, particularly concerning gas-works installations, which operate under conditions probably more severe than may be found in any other industry. Chemical attack has to be resisted, in practically every situation, to an extent that is almost unbelievable and where galvanized conduit and compounded cable have literally disappeared within a period of two years. Again, coke dust of molecular dimensions has been found inside totally enclosed equipment within a very short period of time, and internal insulating bushes on oil-immersed high-tension transformers have been carbonized by local circulating currents from coke-dust deposits to such an extent that solid copper connectors 1 in. diameter have become exceedingly hot, necessitating major repairs. It may be appreciated, that nothing short of the best electrical engineering practice, coupled with continuous vigilance by skilled personnel, will produce absolute safety. The various Factory Regulations, published by H.M. Stationery Office, and the regulations issued by the Institution of Electrical Engineers, set a standard which, under normal conditions, is very high, but in the case of the Gas Industry they should be interpreted as absolute minimum requirements.

(B) Earthing of Apparatus

Regulation 21 of the Regulations for the Generation, Transformation and Use of Electrical Energy in Premises under the Factory Act (1901-1911) states that adequate precautions shall be taken to prevent any metal other than an electrical conductor from becoming electrically charged; this, as far as the Gas Industry is concerned, means that all metal work used in connexion with electrical apparatus must be efficiently earthed. The character of an installation requires special attention, inasmuch as metal gas mains are very often found to be of lower resistance than a normal and otherwise efficient earthing system, with the result that frequently they are used as electrical

* From Communication No. 316 of the Institution of Gas Engineers.

earths. Leakage currents then become apparent which, with D.C., lead to electrolysis, and perforation of the gas mains. More important from an electrical point of view, the result is usually a corroded earth wire, with subsequent break in continuity, the apparatus then becoming alive and dangerous.

With an A.C. system, leakage currents usually develop very rapidly into faults severe enough to operate fuses or automatic protective gear. Corrosion of earth wire due to chemical attack is very common, and in several cases earth wires have been known to fail by fusing when carrying fault currents; again, apparatus concerned becomes alive and dangerous. Good practice, therefore, dictates a continuous earth connexion, and this is readily available with screwed conduit or armoured cable, due care being taken to see that all joints have electrical continuity. With lead-covered and armoured cables, it is essential that all joints be "wiped," and bonded with copper or phosphor-bronze strip of suitable section not less than 1 in. by $\frac{1}{8}$ in. for mechanical strength. The whole system can then be grounded at one point by suitable earth-plates or pipes but on no account should earth connexions be made to any gas service or main.

Leakage indication is necessary on D.C. systems, but on A.C. its use is purely optional; it is, however, very easily fitted and is advocated.

(c) Emergency Control of Apparatus

Home Office Regulations require that means be readily available for stopping moving machinery, and in most cases this means cutting off the supply to the electric motors. With ever increasing use of conveyor installations in the Gas Industry, this problem assumes considerable importance, as in many cases the control gear is situated at some distance from the plant. It is very doubtful to what extent accidents can be prevented by the provision of emergency-stop stations, inasmuch as their operation usually calls for the attention of a second person who is rarely available, but careful consideration given to the electrical and mechanical details of such emergency-stop stations can help to reduce their occurrence and severity.

Accessibility and reliability would appear to be the main factors, but long conveyor runs and numerous individual drives provide a most difficult problem. Group tripping and the use of longitudinal trip cables with manual reset trip switches will give the required facilities from an accessibility point of view: reliability is not so readily obtained, and in the main it is dependent upon the choice of the trip circuit. Perhaps an outline of some faults which have occurred on emergency trip circuits will serve to emphasize this point:

(*a*) An open circuit in the wiring of a shunt-trip coil caused failure of trip mechanism, so that all emergency pushbuttons were out of action without anyone being aware of this situation.

(*b*) Toggle mechanism of a no-volt circuit was found to be stuck due to slight wear of moving parts. Here again the trip circuit was out of action.

(*c*) Carbonization of a bakelite terminal strip caused an earth fault which held in the main contactor coil, and in this case the trip circuit failed to operate.

These are only three typical faults which occur with regular frequency, the result being complete failure of the emergency tripping stations. In many cases it is favourable to mount the main switch near the running machinery, in which case cutting of the supply to the motor is readily done, but here again cases are on record where main switches have failed to trip and serious accidents have resulted.

(d) Portable Apparatus

To the electrical engineer responsible for a large works, portable apparatus can be a veritable nightmare: in general, the apparatus is treated as an easy and ready method of carrying out many processes such as drilling, grinding, and lighting, and under such circumstances it is understandable that very temporary and unsafe installations are found.

Good practice on the gas-works demands nothing less than properly earthed and robust apparatus; insulated gear is not advisable because of the rough usage it is liable to sustain.

Portable apparatus should not be used on voltages exceeding 110 volts A.C., and proper earthing of the supply system should be carried out in accordance with the Home Office Regulations: on no account should temporary connexions be made, and industrial-type metal-clad socket outlets should be used on every occasion.

All apparatus should be frequently tested for earthing efficiency, and it is not sufficient to apply a simple continuity test by means of a "Megger" or ohmmeter: these may indicate electrical continuity, whereas in actual fact the earth connexions may not be capable of carrying fault current. Special instruments, which pass a fairly heavy current through the earth connexion, thus ensuring that it is electrically sound, are available for this work.

(e) Handling of Equipment by Authorized and Unauthorized Persons

From the point of view of safety alone, there can be no compromise on this subject; authorized persons alone should be allowed to handle electrical equipment. This, of course, does not imply that a fully skilled man is required to change an electric bulb; indeed, electricians would be very busy people if this were the case. Very often, however, semi-skilled men are expected to carry out work which may have an element of danger; the men appointed should receive proper training and be fully competent in their particular work.

With the more frequent use of bulk supply at high-tension voltage up to 11,000, it should be realized that exceptional care is required in the handling of this equipment. In the electric supply industry, this work is carried out by senior engineers, and unless a gas undertaking has the services of a professional or senior electrical engineer available, it would be well advised to contract this work out to the local supply authority, or, as an alternative, high-tension apparatus can be hired from the electric supply authority which then becomes responsible for routine maintenance, which has to be very rigorous at these voltages.

(f) Flameproof Equipment

Many situations in the Gas Industry require that due consideration be given to the presence of inflammable gases, and precautions must be taken to prevent any piece of electrical apparatus from becoming a source of ignition. To meet this condition the electrical industry provides flameproof apparatus which has been certified by the Ministry of Mines and is defined as being capable of withstanding, without damage, any explosion of inflammable gas which may occur within it; also of preventing such transmission of flame as would ignite inflammable gas which might be present in the surrounding atmosphere.

The principle adopted in the design of such apparatus is, first, construction of an enclosure sufficiently strong to resist the pressure generated by internal explosion, and, secondly, reduction of the magnitude of such pressure by "flange protection" within limits which will prevent the passage of flame to the outside atmosphere. Flange protection is simply the provision of wide, machined, flanged joints with given maximum gaps between the surfaces.

The use of flameproof equipment does not of itself provide a safe installation, and many other precautions have to be taken to ensure adequate safety; one case may be quoted where the strengthening ribs on the cast-iron terminal box of an electric motor driving a benzole extraction pump provided a pocket for moisture which eventually percolated through the gap in the flanges, down the cable and through a compound-filled cable box, finally causing a short-circuit and complete destruction of the crutch of the armoured cable, the lead sheath and wire armouring being badly damaged by external flame from the electrical short-circuit. Many instances of faulty installation have occurred which might have been serious had an internal explosion taken place; cable boxes have not been effectively sealed, flange gaps have been gasketed with perishable material, surplus conduit holes have been filled with compound or covered with thin sheet metal, and very often bolts are omitted from covers after routine maintenance.

In general, it has been found that the principles of flameproofing are not understood by skilled personnel other than those continuously employed on this type of apparatus, and more use should be made of the excellent publications of the Mines Department on this subject.

The use of flameproof equipment should not be considered to be an ideal method of achieving intrinsic safety; without doubt, it is far better to remove electrical apparatus completely away from dangerous gases whenever that is at all possible. This can be achieved by constructing separate rooms for electric motors and by providing extended shafts to pass through sealed wall bearings. Again, when flameproof apparatus may not be fully justified, consideration should be given to pressurized equipment; *i.e.*, equipment which is supplied with free and filtered air from an external source. Air should always be blown into the equipment rather than supplied by suction which may cause intake to the apparatus. When this principle is adopted, it should always be borne in mind that the size of the motor can be considerably reduced.

Electrolysis

(a) General to Electrolytic Corrosion

Electrolytic corrosion of underground metal structures constitutes a serious problem, neither fully appreciated nor understood, which has caused much damage to long lengths of gas mains, and in one case seriously perforated the metal base plate of a waterless gasholder.

Any underground metal structure subject to a potential difference between itself and the general mass of earth will become the source or terminal of an electric current (depending on whether the structure is positive or negative to earth), which will result in corrosive

action which is most severe when the structure is positive to earth. If the structure is negative to earth, the action is of a secondary nature (as is also the case with A.C.), and is not serious. A potential difference cannot occur without the passage of an electric current, so that some condition must arise within the general mass of earth leading to the generation of electric current (*i.e.*, galvanic action consequent upon soil water becoming electrolytes), or the straying of electric currents from their normal and proper channels (*i.e.*, faulty underground cables, &c.). In gas mains and the various metal structures used on gas-works, an ideal "earth return" circuit is provided which can be considered most efficient from an electrolysis point of view. Should any stray currents be present, they will undoubtedly pass to these structures and cause untold damage. Further, it should be realized that under favourable conditions and over long periods infinitesimal potential differences may cause considerable damage.

(B) Prevention of Electrolysis

The ideal method of preventing electrolytic corrosion would be to insulate all underground metal structures (including gas mains) so that leakage currents could not pass through the insulation to the metal work and thence to the "earth" side of the electrical system; unfortunately, such insulation is impracticable in most cases, although normal pipe-wrappings give some little protection. Earthing of underground metal structures by means of "earth" plates or pipes is very often used and will generally reduce corrosion if maintained in good condition. It is obvious that corrosion will be transferred from the metal structure to the earth plate, and that the earth plate will only be efficient so long as its resistance is less than that of the structure; it will be corroded at a rate proportional to its effectiveness. There are, however, instances when earth plates can increase leakage and be very detrimental to the installation; they should, therefore, be applied with great caution, and it should be clearly understood that a reduction, and not complete elimination, of corrosion can at best be obtained. Gas-works structures, such as gasholders and large mains, offer such ideal "earths" that special precautions should be taken to avoid leakage from gas-works electrical plant, and no better method can be adopted than to make the installation all-insulated (*i.e.*, no earth returns on telpher lines and cranes, &c., as is general practice on traction systems). Continuous leakage recorders should also be installed, and routine tests of plant insulation regularly carried out by competent persons.

Maintenance of Plant

(A) Routine

Very few industries have been able to maintain a rigorous maintenance programme over the past few years, and the result has been an ever increasing stoppage of plant for emergency repairs, with consequent loss of production. Too much emphasis cannot be placed upon the necessity for carrying through at all times a rigorous maintenance scheme, particularly with regard to electrical plant which can so easily become a source of danger to life and limb. The routine to be followed is one of weekly inspection and cleaning, with periodical insulation and "earth" tests about every three months, faults being rectified immediately they are located.

(B) Records

It is most essential that some record be made in connexion with routine maintenance, but it is equally obvious that maintenance personnel should be employed on maintenance, rather than statistics, which contribute little to plant reliability. Records must therefore be kept simple and should contain only information vital to plant wellbeing.

The plant is best indexed under schedule numbers allocated to each motor drive, and should contain as many particulars as are deemed necessary for the ready servicing of any item on that drive.

(C) Personnel

The choice of maintenance personnel is one of some difficulty, inasmuch as the work is monotonous and gives little obvious result; the service is therefore liable to deterioration, particularly if skilled men are employed on work which is little more than unskilled cleaning. A specially trained semi-skilled staff (under the control of a fully skilled man) can very well deal with all routine cleaning, inspection and repairs, and in this manner it is possible to conduct a maintenance scheme entirely independent of installation work. Further, it offers an incentive to unskilled men who would otherwise have little or no opportunity to improve their positions, and so considerably improve the usefulness of this class of labour, at the same time reducing the demand for skilled labour which is so vitally important at the present time.

(D) Supervision

Supervision can become a very costly and unproductive item in any maintenance scheme; too often, due to the diverse nature of gas-works plant, it constitutes merely the allocation of labour and materials. Again, maintenance is usually carried out when opportunity offers, so that supervision of actual work done is almost impossible; at the same time it is imperative, from an engineer's point of view, to see that the maintenance programme is rigorously observed. Supervision in these circumstances can best be applied by allocating the work in such a manner that each man carries a certain degree of responsibility which overlaps that of the next man and is remunerated accordingly. Thus, in a large plant, several semi-skilled auxiliary plant attendants would carry out routine inspection, cleaning and repairs, together with and under the supervision of a fully skilled man, for a particular section of the installation; an independent plant inspector would be responsible for carrying out inspection on all the sections of the plant, and lastly, an emergency service would be provided to cope with breakdowns out of normal working-hours. In this manner, every man in the course of his normal duties supervises the work of a lower-rated man, each carries out his work knowing well that any lapse will be quickly observed by the next man or finally attested from the number of breakdowns which the emergency service may have to attend.

DISCUSSION

Mr. **F. M. Birks** (Deputy Governor, Gas Light and Coke Company): It is indeed a great step forward for an undertaking to have been able to make arrangements for interconnexions to the grid supply. The negotiations may have been easier by the fact that the electricity and gas undertakings are both municipally owned. It has, nevertheless, provided a most useful precedent and will be of very great help to others who are negotiating on similar lines. It would be safe to say that there are examples of electrification of every power requirement of a gas-works which have been well tried out and proved successful, so that provided adequate safeguards as to the electric supply are available, there need be no hesitation in carrying out electrification to the fullest extent.

As the Author rightly says, there is little need for variable speed motors in the Industry, as in many cases, particularly when driving non-positive machines such as centrifugal gas or water pumps, all the control necessary can be obtained by governing the working fluid. Nevertheless, I hope soon to have experience with a variable speed alternating current motor of about 290 h.p., driving a large gas compressor, the speed being infinitely variable from 960 r.p.m. down to 480 r.p.m., as there may be a few instances where such machines can be profitably used.

I would like to put in a plea for the greater use of pass-out turbines. They are, of course, more expensive than the simple back-pressure type, but they can operate over a much wider range of conditions that it may be found that this higher initial outlay will be justified more often than generally realized, by affording a much greater flexibility to the carbonizing process.

The Author says: "It is very doubtful whether there is any other industry which offers such scope in waste-heat recovery as the Gas Industry; many works already raise steam at low pressures in this manner, but unfortunately it is allowed to fritter away on inefficient drives."

Due to the able work done on this subject by Dr. Pexton in conjunction with the makers, I think it can be safely claimed to-day that it is possible to operate a carbonizing plant with a producer fuel consumption of about 10% of the weight of the throughput of coal; this, of course, results in much less heat being available in the effluent gases with which to raise steam. Sufficient, however, can be raised by this means to provide all the process steam required, together with more than sufficient power for all purposes, after full electrification visualized by the Author has been carried out. Such results are at present only obtainable when supplying gas of about 500 B.Th.U. per cu.ft., after benzole washing. The overall works' fuel consumption is increased as calorific value is reduced by further steaming.

The overall thermal efficiency of the works would then be very high, but to carry out the alterations necessary to obtain such results would need a considerable capital expenditure and would take considerable time. The savings might prove to be much greater than visualized by the author as 385,000 tons of fuel per annum and might even reach two million tons, although a large proportion of the fuel saved would be in the form of breeze.

Hitherto there has not been a very great inducement to increase efficiency to this point due to the instability of the market for breeze, and it is earnestly to be hoped that the national fuel policy

of the future will operate so that it will be possible to rely on a reasonably steady price for a sufficient term of years to justify undertakings embarking on such improvements. The time has arrived when the whole subject should be freely ventilated and I know that there are young engineers in the Industry with wide general knowledge of the technical and economic possibilities involved, and I do earnestly suggest that they should put forward their views to technical associations and that every encouragement should be given to them to do so.

Specialized Knowledge

Mr. **E. Crowther** (Newcastle-on-Tyne): The Paper affords an excellent illustration of the contribution which may be made to the technique of one branch of engineering by a man whose training and experience have been mainly obtained in another branch. It is inevitable that specialization should increase, and to keep abreast of developments an industry requires to have access to the specialized knowledge of every field of activity which touches upon its work. It has been very instructive to have the views of an electrical engineer upon the power practice of the Gas Industry, and while our own experience may cause us to be critical of certain of his conclusions, there can be no doubt that Mr. Rimmer has done us a considerable service in drawing attention to some aspects of his subject which can with advantage be reviewed.

If the Paper has a fault, it is, in my opinion, that it endeavours to cover so much ground that its matter has too often been unduly compressed, and I at least would have welcomed a fuller treatment of some sections even at the expense of the exclusion of others. At the present time, and in face of the admitted shortage of public generating capacity, which we are informed cannot be made good for some four or five years, it requires courage to advocate a policy of fuller electrification of gas-works plant.

Mr. Rimmer recognizes that continuity of operation is imperative in the case of much of our plant, and seeks to meet this by recommending the provision of a duplicate supply, either by means of duplicate public mains, or by a combination of public supply with private generation, but even with such safeguards unexpected difficulties can occur in exceptional circumstances.

For example, at a Durham coke oven installation, powered entirely by A.C. motors, the simultaneous voltage and frequency reductions which continued for considerable periods during the past winter so slowed down both the coal and coke machinery and the exhausters as to have very marked and unwelcome effects on the throughput of the installation, and on the gas available per ton of coal.

Again, the registration of a number of important inferential gas meters, of which the integrating mechanism was operated by synchronous motor, was made completely inaccurate by the reduced frequency, and it is debatable whether the attempts made at certain times by the Central Electricity Board to overhaul lost cycles, or the complete writing off of lost time on other occasions gave the greater trouble.

Possibilities of Failure

Possibly the greatest objection which can be raised against electrification of vital plant is, however, the possibility of motors failing abruptly, and without preliminary warning. At another coke oven installation with which I am familiar, a booster driven by electric motor was installed during the war to deliver gas to a gas undertaking. On four occasions within little more than a year of its installation, the stator insulation broke down, and the booster ceased to function. The makers who (no doubt rightly) attributed the trouble to inferior war-time materials and labour, were eventually obliged to rewind the stator with glass fibre insulated wire, phenol varnished.

Such stoppages as this, against which duplication of supply is no protection, cannot well be foreseen with even the best system of maintenance, and they might be very serious indeed in the case of certain gas-works plant. The steam engine, on the other hand, almost always gives ample notice before a breakdown, and if for no other reason than this will be very hard to displace from certain duties, notwithstanding its relative inefficiency. At the same time, I accept a very great deal of what Mr. Rimmer has said, and agree with him that largely as electrical power has been applied to gas-works plant, more could with advantage be done in this direction.

The day of numerous small isolated steam engines and pumps has gone with that of cheap fuel, and even where a works is too small to contemplate the expense of stepping up its steam pressures and installing pass-out turbine driven generators, it would probably pay to confine its steam usage to that capable of being raised by means of waste heat boilers and to convert to electric drive so much of its less vital power using plant as there is not sufficient steam to serve.

In passing, the present inefficient steam layout of too many works may be explained, though perhaps not justified, by their history. They have generally developed over a long number of years, their steam system having been installed when Lancashire boilers, with the advantage of their high steam storage capacity, were standard practice, when both fuel and labour costs were very low, and when steam pressures over 120 lb. per sq.in. were exceptional. Engines, steam ranges, and boilers alike were designed for such pressures, and a stepping up of pressure would entail a very radical replacement programme. It is probable that such a programme would often be profitable under the altered conditions of to-day, and if Mr. Rimmer's Paper leads to an examination of the economies of such a revision in individual cases it will have served a most useful purpose.

I will not attempt to touch on more than one or two of Mr. Rimmer's specific points, and that rather by way of a request for more information than of comment. In his remarks on process steam, he says, "care must be taken to see that sufficient pressure head is available to extract the latent heat." His meaning is less clear than I could wish. The section of the Paper dealing with some conversions from steam to electric drive will be of particular interest to gas engineers concerned with boosting problems.

One would like to know why, at one boosting station, variable speed D.C. motors were adopted, whereas at another station constant speed A.C. motors were selected. In the latter case Mr. Rimmer states that efficiency was not impaired by outlet gas pressure control (that is, presumably, by throttling), but is it not generally accepted that for light load running, if A.C. is used, a variable speed motor of the Laurence Scott type consumes considerably less power than does a constant speed machine?

Another alternative, on which I should like to hear Mr. Rimmer's views, would have been to introduce fluid friction transmission, of the Vulcan-Sinclair type, between constant speed motors and variable speed boosters. Such a system has, I believe, been employed with satisfactory results in several installations.

Without more information on the arrangement and duties of the booster stations cited in the Paper, and particularly without knowing whether the machines are required to develop a constant outlet gas pressure irrespecive of volumetric delivery, or whether pressures increase in proportion to the square of the volume, detailed comment upon the method of working is not likely to be very useful.

Experience with twin machines of non-positive type delivering against pressure heads regulated by the volume of flow would suggest, however, that instead of the provision of twin small boosters and one large machine, as in the first station mentioned in the Paper, a more favourable arrangement would consist of one small, one medium, and one large machine, but it may be unfair to put this point to Mr. Rimmer, as it falls rather outside the province of his Paper. I should have liked to ask him to expand his remarks under the heading of "Instrumentation," but must leave it to other speakers to do this. In the meantime, I would thank him for a very useful, practical and informative contribution.

Electrical Safety

Mr. **H. F. Swann** (H.M. Senior Electrical Inspector of Factories): I am interested in this Paper mainly in connexion with electrical safety, and after reading Mr. Rimmer's informative Paper I am led to think that there are many problems which he anticipated in the application of electricity to gas-works which are common in other large installations such as water pumping and oil pumping works. I think many of these arise from the fact that the mounting of an electric motor on a baseplate of a pump, booster or whatever it is provides a metallic contact between the metal work of the electrical system and the metal work of the works system whatever it is. Three or four weeks ago I had the privilege of addressing a meeting of water engineers and one of the things which was stressed was that it is the definite policy of water authorities to extend the use of asbestos cement of the non-conducting type and that assists stray electric currents to find their way home.

Mr. Rimmer says—and he emphasized the point in presenting the Paper—"The electrical protection of the whole system requires something better than the haphazard installation of overload devices." I quite agree. There are three functions of a circuit protective device which must be fulfilled for satisfactory operation. The first is the protection of the bulk control against the effect of consistent over-current. The second is the ability of the protective devices to clear a short circuit, and that function must have regard to the full energy available on the generating side of the control apparatus, and the position in that respect is very different to-day from what it was 10 or 15 years ago. Great trouble is being experienced in my Department from the fact that protective devices are not adequate having regard to the fault input rather than any inherent inability to bear a short circuit. Thirdly, the function of circuit protective devices is to take care of earth faults.

The Author says that an earth fault soon develops into a short circuit and that then it is taken care of by the circuit protective devices, but I submit that we do not know how soon a fault to the surrounding metal work will develop into a short circuit which

can be taken care of, and I suggest again that in the electrical industry as well as in the gas and many other industries, this problem of dealing with earth fault currents is not receiving the attention it should. For instance, how can the engineer know whether his circuit protection is capable of clearing earth faults unless he knows what are the limits of the current which can flow should a fault of that description occur? In order to give the required degree of safety, he must speak in terms of a ratio, *viz.*, that of the setting of the protective device to the resistance or impedance of the path which the fault current will take should some form of leakage occur either to the metal or lead sheath or whatever it is enclosing the conductor, and the general mass of earth for the whole of the loop current, which that fault current must traverse in order to return to the generating station. I want to get that point clear. It is the loop resistance of the path which the fault current must traverse to return to the generating station or subsation which determines, or should determine, the setting of the protective devices controlling the circuit, and unless some form of measurement is taken first of all to establish that that ratio is the optimum ratio, then the position is insecure.

Function of Protected Gear

I want to go now to where Mr. Rimmer says: "The primary function of protective gear is to disconnect faulty apparatus from the system as rapidly as is consistent with the severity of the fault. At the same time, it must not allow interruption of any other running plant." A little later he says: "Overload protection, which has varying time delays and graded current settings, is commonly employed for this purpose, but with small plants it is very difficult to obtain a series of settings which will operate satisfactorily and in correct sequence on all but the simplest of faults." I think it may be of some assistance to say that this problem is far from being a new one in the electrical industry and the need for something definite being done has been recognized. It is not breaking confidence if I say that there will shortly be published a Paper prepared by some technical people in Yorkshire which will cover a method of providing sequence protection, taking into account the statistical variation in the setting of individual relays. The authors of this particular Paper have shown what are the minimum time intervals necessary to ensure that the chance of relays operating in the wrong order is not greater than one in 1,000, and I think that if we find sequence control can be produced to that degree of reliability, a great step forward will have been made.

May I come now to Mr. Rimmer's reference to instrumentation. There again, his problems are very similar to those we have encountered in oil works, coke oven practice, and in chemical works where electrical instrumentation is now very common and very highly developed and, if I may say so, very intricate. The Author says: "Basically, every physical quantity must be converted to an electromotive force. . . ." That means a certain proximity of electrical conductors. Drawing a comparison with the use of oil, there were, during the war, many large scale plants set up for testing high power engines intended for aircraft. In order to get a complete record of the performance of the engines, it was necessary to establish control bases which were equipped with all manner of electrical and other forms of protection and pressure devices, all assembled for the convenience of the operator on one bench. The top of the bench looked very nice, but underneath it looked awful and we had a series of explosions of petrol vapour and gas caused by electrical ignition. I think the gas recording instruments might have tended towards that and I mention it together with a word of warning, but that difficulty can be overcome, and, indeed, has been overcome in chemical works. One way is by the adoption of the principle of intrinsic safety, and I use the word in a rather different sense from that in which Mr. Rimmer uses it. I mean that the instruments are operated by so small an electric current, and the energy of the circuit is so low, that they are incapable of igniting coal gas. Another way is to keep the instruments wind-swept or to have them in enclosures where the air is changed frequently.

Earthing of Apparatus

The Author gets right on to my ground where he talks about the earthing of apparatus, and I support his reference to the advisability of leakage of indication of D.C., but I would like him to go a shade farther and say that it is rather more than advisable —it is necessary.

The Author mentions that he has had some trouble with control buttons on switchgear, but I think there must have been something wrong with the design because it is a very strong principle that all control apparatus should fail for safety and it should not be possible for them to fail in any other way.

With regard to portable apparatus it is a fact that this, on mains pressure, can cause quite a number of electrical accidents. In 1945, as much as 43% of fatal electrical accidents in factories were caused by portable electrical machinery, and for that reason I strongly support Mr. Rimmer's suggestion that the voltage for portable electrical apparatus should not be more than 110 volts. There is now a fairly well established trend towards the adoption of that pressure for portable tools, and in general arrangements can be made to use transformers on which the centre points are tapped to earth so that the shock pressure is not more than 25 volts. In that way, I do not think you are likely to have electrical accidents because during the last 25 years I have only known of two cases of death resulting from shock from a 100 volts, 50 cycle supply, or up to that pressure. One case was in this country and the other was abroad. If we do no worse than that at 110 volts, we need not worry. Various other industries such as brickmaking, cement, building, railways, docks and chemicals are all tending towards the use of this reduced pressure with portable electrical tools.

The Author refers to the need for co-ordinating work on electrical conductors, and here I would like to say that in the electricity supply industry as well as in large works using electricity, there is now a firmly established system of written "permits to work," and I strongly recommend that.

Under the heading of "flameproof equipment" I should like to know the Author's view on the relative danger in purifier houses when electrically-operated hoists or lifts are used, sometimes over the lids of the purifier boxes. There have been accidents which may have been caused chemically or electrically. I am at the moment dealing with a case in which it is proposed to close the area and flush it with fresh air.

Electrolytic Corrosion

One word in conclusion about the points raised by the Author with regard to electrolytic corrosion. He says the problem is neither fully appreciated not understood, and I think he is quite right about that. Apart from the current which may get into the gas or water systems, there is a bad effect which is not always appreciated, and that is that there is a regular and permissible tolerated leakage of electricity that is going on all the time, and it is recognized in legislation. A "permissive" clause appears in the Regulations made by the Electricity Commissioners which allows a leakage through the insulation of any installation of not more than 1/10,000th part of the maximum demand. That does not seem much until you think of the very large size of many installations to-day and their very big aggregate load in a City such as Birmingham. Taking the case where the load might approximate to 23,000 kVA at 230 volts to earth, the total permissible leakage from an installation of that order would be 10 amperes. How that 10 amperes is distributed we do not know because we consistently seem to ignore trying to find out very much about earth currents, how they flow, where they flow, and what damage they do. If one thinks in terms of very large blocks of load in large works or in large areas, and speculates on the possibility of having a leakage of that order, and then goes further into the matter of partial rectification of A.C.—very little work has been done on that—it ties up very closely with the points made in the Paper about galvanic action. The Author states that untold damage has been caused by galvanic currents set up by the contact of dissimilar metals or the carbonaceous matter surrounding them. I wonder whether partial rectification is a possibility which should be taken more into account. I have also wondered whether, where the conditions are difficult to correct, where it has been found by test measurements that buildings, steel structures, pipework, gasholders, &c., are, in fact, positive—and, as the Author says, are suffering structural damage by deterioration—it would be possible to reverse the polarity by some form of negative boost. I remember in some electrical gear many years ago we had to have negative boosts on rather a large scale to keep down the potential of the return current in the tramway rail. I have never heard of a case where anything approaching that system has been used to suppress electrolysis in other directions. It may be that the values are ridiculously out of court, but perhaps somebody may know more about this idea.

A Long Felt Want

Mr. G. E. Currier (Bradford): It can at once be said that this Paper fills a long felt want. It is authoritative and progressive, and will be regarded as a Paper which must be readily available for reference purposes. The use of electricity in the manufacture of gas is being extended continuously, and is likely to be accelerated with the installation of larger production units. The Paper is full of expert advice on the use of electricity in gas-works, but the section which, to me, is of absorbing interest, is that which deals with the paralleling of public supply and private generation. The Author clearly indicates the steps necessary to bring this about, and as this system is a practical proposition, then the complete electrification of all power drives can be carried out. The paralleling of town supply with private generation becomes essential to avoid any interruption of supply, even for an instant.

In considering complete electrification of all power drives, there seems little to be gained by the electrification of exhauster and feed pumps, bearing in mind that these only represent a small percentage of the power usually used for steam drives. The

"NO LOSS" PRESSURE GAUGES

The title "No Loss" is derived from the type of liquid that is used as the indicator, and this liquid, covered by patent, is the most important feature of the gauge.

With the growing demand for more accurate control of Gas Plant, sometimes under severe conditions, measuring apparatus, particularly pressure gauges, capable of meeting the requirements has been repeatedly asked for.

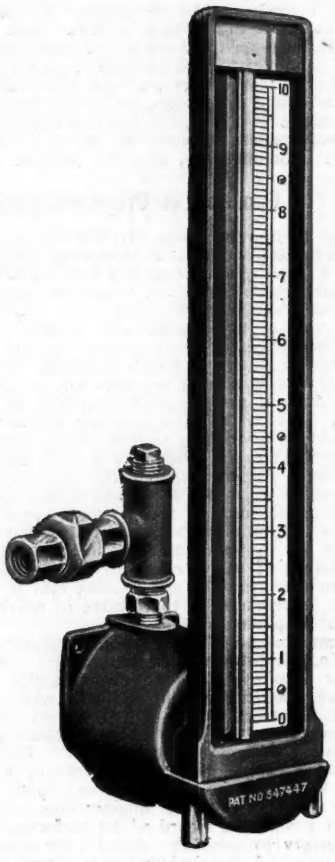
There are many places such as the retort house and exposed plant of a gas-works, or the gas-fired furnaces employed on the thousand and one uses to which gas has proved so adaptable, or the gas-fired ovens used in the confectionery trade where the extremes of temperature give rise to difficulties when using liquid pressure gauges or manometers.

The water column gauge in its two main forms, single column and double column, has proved to be most simple and efficient in use, except for the fact that in warm surroundings, it is necessary to keep a constant check on water level to recover the loss in level due to evaporation, and in cold weather, exposed gauges will freeze up. A gauge which overcomes these difficulties has now been produced by using a special liquid and scale.

This liquid will not evaporate at temperatures well above the boiling point of water neither does it freeze at temperatures below the freezing point of water, it does not absorb or deteriorate when in contact with gas and it is not chemically active on metal or glass. Its density is slightly heavier than water hence the use of a special scale.

The construction of the gauge is simple yet robust and of pleasing lines, whether standing on its base or fastened to a wall or board. Being a single column gauge it is easy to read.

In addition to the pressure reading scale, space is provided for the addition of another scale calibrated to indicate per cent. of full flow. This means that if the full flow pressure is known, then a scale can be supplied that will indicate with reasonable accuracy whether the gas control is set at ¼ or ½ or any opening between shut and full.



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exhausting plant is the nerve centre of any gas-works, and gas engineers have always been attracted to the steam-driven exhauster by reason of its wonderful reliability. However, with the paralleling of electricity supplies, the question of electricity or steam for exhauster drive is mainly one of economics.

It is agreed that general electrification of gas-works drives is desirable, but it is questionable whether it is better to retain private generation as a standby to town supply driving exhausters and feed pumps with steam, or to run continuously in parallel with town supply. Much depends on costs which, according to circumstances, can vary considerably between one undertaking and another. Except in the case of large units, it is possible for private supply to cost more than public supply.

Returning to the practice of the paralleling of supplies, some of the advantages will be nullified if the payment received for exported energy is less than the cost of private generation. The Author states: "Over a period of about twelve months, charges for public supply have been reduced by at least 50% and some 3.6 million units have been exported to the electric supply department for which an average price of 0.41d. per unit has been received." This is understandable, because more has been privately generated and less purchased from towns supply. The quoted statement is incomplete, and one would like to see some reference to costs. If, after crediting all the advantages of working, it costs more than 0.41d. to generate at the works, then the more generated and exported, the greater the loss, and it ceases to be a commercial proposition. Even with waste heat steam, private generation is likely to cost more than 0.41d. per unit in all but the large and extremely efficient works.

Generation Costs

The Author gives the following generation costs with steam at 3s. 6d. per 1,000 lb.:—

Small generator, say, up to 200 Kw.	2.0d. per kWh.
Generator 400-1,000 Kw. condensing	1.0d. „ „
„ „ „ with 80% load factor	0.63d. „ „
„ „ „ back pressure unit	0.21d.-0.18d. per KWh.

Private generation is costly on all but the large machines with back pressure or pass-out engines. The high efficiency and low cost of production of back pressure sets is conditional on *all* exhaust or pass-out steam being used for process work *all* the time. In many cases this will be an impossible condition. Process steam will generally be confined to:—

Retorts and producers.
Benzole plant.
Ammoniacal liquor plant.

In winter time, pass-out steam may also be used for:—

Gasholders—anti-freezers.
Heating of buildings on works.

It is probable that these requirements can be more than met by back pressure steam from large generators with complete electrification of power drives, and particularly during the summer months there may be surplus steam with consequent loss in efficiency. This position may be met by reducing private generation and increasing town supply, but in doing this the load factor of the generator may be reduced much below 80%.

The cost ratio of town supply to private generation has been reduced during and since the war period as a result of greatly increased fuel and labour costs.

The Author refers to fuel-fired boilers, and it would be interesting to have more details of the mechanical chaingrate stoker employed, together with cost of repairs and maintenance, and also the method used for the removal of flue dust.

In connexion with waste heat boilers the Author suggests steam generation at 350 lb. per sq.in. It is doubtful if the normal design of waste heat boiler used in retort houses is suitable for these high pressures, and serious trouble with tube leakage would result.

This is an excellent Paper dealing with a subject discussed all too infrequently by this Institution, and it is of the utmost importance with the present trend towards larger production units. A survey of existing energy production and power drives considered alongside the alternatives suggested in this Paper may reveal some startling economies, particularly for the larger undertakings.

High Tension Supply

Mr. **H. F. Buxton** (Wandsworth): I think the Author has unduly stressed the advantages of a high tension supply. While such a supply is desirable for the large works a 3 phase, 400 volt, supply can fulfil the requirements of a small or moderately large works quite satisfactorily, bearing in mind:—

(1) Economies obtained in distribution switchgear and cabling.
(2) Possibility of duplication of supply.
(3) Ease of parallel operation of the gas undertaking's own generating plant with the public supply, where permitted.
(4) The negligible disturbance reflected back to the high tension mains by the starting of squirrel cage motors connected to the low tension network, and
(5) The impossibility of obtaining switchgear of sufficient current rating and proved rupturing capacity for operation at low voltage.

The impression is also given regarding the installation of 45 H.P. and 25 H.P. motors at 500 V. that any motors can be wound for high voltage. This, of course, is not the case, and it is doubtful whether any manufacturer would wind a motor of less than 150 H.P. for 3,300 V., and for 6,600 V. the H.P. would have to be much higher. Parallel operation of the gas undertaking's generating plant with the public supply as discussed in the Paper is interesting, but the Author is in the fortunate and somewhat rare position of having the closest co-operation of his City's own Electricity Department. We are not all so fortunate, and all the supply authorities with whom I have dealt look askance at parallel operation and are horrified at the thought of a gas undertaking supplying them with its surplus energy.

The section dealing with electricity generation on gas-works is worthy of the closest study. The Author is evidently in the happy position of being able to utilize high steam pressures and temperatures and while agreeing that the use of back pressure turbines is an ideal to be aimed at it is not at the moment practicable for many of us in view of the replacements of boiler plant and modification to steam mains and other equipment which will be necessary.

Generation Costs

The generation cost figures which are based on steam costs only, would bear a truer relation to the facts if capital charges, wages, and maintenance had been included. It would also have been useful to have information on the cost of purchased energy.

Leaving out the question of operation with the public supply, a facility which is available to few of us, it would have been interesting to hear the Author's views on when to generate and when to buy, and what standby plant to install. It would appear that the border line occurs when generating sets of the order of 150/250 K.W. would have to be installed. Each case requires individual consideration, but in general I believe that below this figure it is better to purchase energy and install standby generating plant and above it to generate and if desirable bring in the public supply as a standby.

It is surprising that the use of diesel engine generating sets either as main or standby units is not mentioned in the Paper and I feel that this is an economical method of generation which has on the whole been neglected in the Gas industry.

The section on generation points the way to logical development, and the picture of the future large gas-works raising steam at high pressure and temperature from waste heat or low-grade fuel, using exhaust steam for process work, operating its own generating plant in parallel with the electric grid and exporting surplus energy is one which should appeal to both gas and electrical engineers who have good engineering practice and the national interest and economy at heart.

Turning to the question of distribution, it is difficult to see why the Author prefers the bus cable system to normal or tree system. In the former a fault on any part of the bus cable will necessitate shut down of all services tee-ed in to it, whereas the latter does permit an individual feed to each important item or group of items and can be quite reliable provided that suitable safeguards are used. The ideal is undoubtedly the ring main system which we are installing on a considerable scale for both direct and alternating current supplies and with which a duplicate feed can be arranged to each important site.

I was rather surprised to see a photograph of a tee-off in a buried cable. The use of buried cable, particularly where the ground has been used for gas making for many years, has given us considerable trouble due to damage by chemical action and we will not now permit the use of any buried cables. All cables are racked to buildings, carried on special bridges or suspended from catenaries. Catenaries corrode, but can be examined frequently, the cable is visible all the time and suffers no damage. Great emphasis should be placed on the selection of suitable cables which almost invariably should be of the lead covered and armoured type. Copper sheathed mineral insulated cable may be used in very hot situations. Conduit should never be used except for short runs of a few feet.

Enclosure of Gear

I heartily endorse the Author's remarks about enclosure of motors and control gear. Nothing but the best is good enough. No light sheet metal should be permitted anywhere and all switchgear, control gear, limit switches, control switches, &c., should be in dust and damp proof enclosure made from heavy boiler plate or cast iron, glass inspection windows and ammeter faces being protected by wire mesh or metal grids.

On the subject of motors I should like to say a few words in defence of the D.C. machine. It has been developed over the past 50 or 60 years into a most reliable piece of equipment and as the Author admits is efficient over a wide range of loading and easily lends itself to speed variation. In addition, due to its

speed/torque characteristics it is prominently suitable for traction type drives such as horizontal retort house charging machinery and telphers. In my opinion its use can still be justified for small works provided the voltage is limited to a maximum of 230, and those of us who are committed by force of circumstance to its use in our larger works need not be dissatisfied.

I am glad to see that the Author has stressed the importance of selecting the right motor for the job, particularly in the case of squirrel cage machines. Several manufacturers make four or five distinct types with characteristics suited to different purposes and they should always be consulted as to the most suitable type.

In dealing with the synchronous motor, mention should have been made of its valuable property of operating at unity or leading power factors, and its use might well be considered for driving large boosters running at constant speed, thereby improving the overall power factor on a works having a large induction motor load.

Conclusion of Terms

There is some confusion which is fairly common throughout the electrical industry of the terms used to describe the various types of synchronous motors. All synchronous motors with the exception of the small machines described which have a poor electrical performance require separate D.C. excitation when running in synchronism. Where such a motor is run up to speed by an auxiliary motor it is referred to plainly as "synchronous." Alternately it may be designed to run up by itself with a squirrel cage winding inserted in the rotor pole pieces or it may have a wound rotor similar to that of a slip ring machine. Both these types are sometimes referred to as auto-synchronous or self-starting-synchronous, and the latter sometimes as synchronous induction. When nearly up to speed a D.C. supply is connected to the secondary winding and the motor pulls into synchronism. The former type has a starting performance inferior to that of the squirrel cage induction motor, and the starting performance of the latter approximates that of a slip ring induction motor.

On the subject of control gear, the question of hand versus automatic operation is an ever fresh topic for debate. On the whole I prefer to use hand-operated equipment except where automatic gear is essential for the duty. Excellent though much automatic gear is, it is more prone to involuntary stoppage due to trouble in auxiliary contacts and auxiliary circuits and requires considerably more maintenance.

Safety Precautions

I am very glad that the Author has given so much space to safety precautions. This is in itself a comprehensive subject, but I should like to make the following brief comments :—

(1) It should be emphasized that the steel frames of buildings are no good for earthing purposes. One still finds them used on occasion for this purpose and it is surprising what a high resistance to earth many of them have.

(2) All emergency stop push buttons of the manual reset type should be used in conjunction with control gear of the loose handle type, otherwise there is the danger of an operator holding the starter in the "on" position even though the push button remains open.

(3) It is desirable that any lamps should operate at even lower than 110 volts, particularly in damp situations ; 25 volts is quite suitable and is easily obtainable from transformers when an A.C. supply is available. Portable tools present greater difficulty, but one switchgear maker markets a proved earth equipment in which any breakage of the earth lead disconnects the tool and renders it inoperative.

(4) The Author's comments on flameproof equipment are very much to the point and considerable discussion and thought could with advantage be given to this subject as it affects gas-works practice.

The Author has, on the whole, confined himself to the subject of electricity as used on the larger works, whereas it is of equal value to the smaller undertaking. He has nevertheless done a great service by putting on record the many ways in which electricity can serve the Gas Industry efficiently, and by showing that its application is a specialized art requiring the closest knowledge of the problems involved and of the means of dealing with them.

The **President** : It is very gratifying to have had such an excellent discussion, and the Author will reply in writing.

LONDON JUNIORS' SUMMER MEETING AT PORTSMOUTH

THE Summer Meeting of the London and Southern Junior Gas Association at Portsmouth on June 14 was an extremely enjoyable event. Members, ladies, and visitors numbering about 150 were the guests of the Portsmouth and Gosport Gas Company, of which Mr. G. G. Warne, President, is Distribution Engineer. Despite unsettled weather a full programme was carried out, comprising an inspection of the Hilsea works in the morning, luncheon at the works, an afternoon tour of Southsea, sea trip to the Isle of Wight, with tea at Ryde, and a cruise round Portsmouth Harbour.

At luncheon the visitors were welcomed by Dr. F. E. Beddow, Chairman of the Company, and Mr. Warne, in response, thanked the Directors for enabling him to make his year of office a success and for their present hospitality.

Mr. W. K. Tate, General Manager, replying to the toast of the Company, proposed by Mr. C. A. Deas, President-Elect, paid tribute to the foresight of Mr. Ashworth in laying out the Hilsea works, and the administrative abilities of the late Mr. Thomas Carmichael. He outlined the programme of reconstruction at Hilsea and on the district which had been worked out to cover the next five years. Plant approved and in process of construction included the reconstruction of the continuous vertical retorts to give a capacity of three million cu.ft. per day, and new coal handling plant, and plans were in preparation for additional purifying plant and a new central coke plant.

The top table at the luncheon. Left to right : Mr. E. Allison, Mr. L. W. Andrew, Mrs. Andrew, Mr. S. E. Whitehead, Mrs. Tate, Mr. G. G. Warne, Dr. F. E. Beddow, Mrs. Warne, and Mr. W. K. Tate.

GAS STOCKS AND SHARES

Market conditions were generally dull throughout the week, with a tendency to recover at the week-end, when prices rallied somewhat, though there was a fall in the industrial ordinary share index from 137.1 to 134.2. The decline in the price of Government securities went further, Treasury 2½% falling to 92½, or 7½ points discount on the price of issue. The overall fall in the Government security index was from 117.87 to 117.25. New and pending capital issues are having an effect on the market. Before the end of the month there will be a public offer of £15,000,000 of 3% Debenture stock in the new Steel Company of Wales, which is only part of the capital required to finance the vast modernization scheme already announced.

In the gas stock market there was slightly more activity than in the previous week, with only slight changes in prices. After touching higher figures, Imperial Continental ended the week two points up, while Primitiva Holdings declined 6d. to 10s.-12s. Chief interest was taken in Commercial, Gas Light and Coke, and South Metropolitan. Price changes recorded during the week were as follows:

OFFICIAL LIST

Croydon, 4 p.c. perp.deb. (xd. June 18)	120	—125	+	1
East Surrey 5 p.c. irred. deb. (xd. June 18)	120	—125	+	1
Holyhead & North Wales, ord. (xd. June 18)	22/-	— 24/-	+	6d.
Imperial Continental cap. ...	122	—127	+	2
Newcastle & Gateshead ord. ...	98	—101	+	1
Primitiva Holdings ord.	10/-	— 12/-	—	6d.
South Metropolitan ord.... ...	94½	— 97½	—	½
Watford & St. Albans 5 p.c. pref.	108	—113	+	3

Quotations on the London Stock Exchange

When ex-Dividend	Dividends Interest.% Last Yr.	Prev. Yr.	NAME.	Quotations June 26
Mar. 12	4	3½	Alliance & Dublin Cons. Ord.	21/6—23/6
April 30	5	5	Ascd. Gas & Water U'd'tgs Ord.	19/6—21/6
"	6	6	Do. Deferred	20/—22/-
Mar. " 12	4½	4½	Do. 4½ p.c. Red. Cum. Pref.... ...	20/—22/-
"	4	4	Do. 4 p.c. Red. Cum. Pref.	19/6—21/6
"	4	4	Do. 4 p.c. Irred. Cum. Pref.... ...	19/—21/-
Feb. 26	7	7	Barnet Ord. 7 p.c. max.	158—163
Mar 12	5	5	Bath Cons. Ord .5 p.c. basic	107—112
Nov. 18	...	10	Bombay, Ltd., Stock	50/—52/-
Jan. 29	8½	8½	Bournemouth Std. 5 p.c. sliding scale ...	173—178
"	7	7	Do. 7 p.c. max. div.	158—163
"	4	4	Do. 4 p.c. Pref.	101—106
"	6	6	Do. 6 p.c. Pref.	128—133
"				95—100
Feb. 12	...	3½	Do. 3½ p.c. Red. Deb.	103—108
June 4	4	4	Do. Perp. 4 p.c. Deb.	105—110
Feb. 26	5·35	5·55	Brighton, &c., 5 p.c. Std. Cons.	115—120
"	6·3	5½	Do. 6 p.c. Std. Cons.	119—124
June 4	5	5	Do. 5 p.c. Perp. Deb.	110—115
Feb. 26	5	5	Bristol, Gen. Cap. 5 p.c. max.	100—105
June 4		4	Do. 4 p.c. New Deb. Red.	117—122
Mar. 12	7½	7½	Brit. Gas Light Ord.	109—114xd
June 18	...	5½	Do. 5½ p.c. 'B' Cum. Pref.	96—101
June 4	4	4	Do. 4 p.c. Red. Deb.	190—200
Feb. 12	10	10	Cambridge U. & T. Orig. 10 p.c. Cons. ...	100—105
"	5	5	Do. 5 p.c. Cons. 'C'	135—140
"	7	7	Do. 7 p.c. Cons. 'B.'	17/—19/-
April 30	...	4½	Cape Town, Ltd., 4½ p.c. Cu. Pf.	122—127
Feb. 12	6½	6	Cardiff Con. Ord.	105—110
Mar. 12	5	5	Cheltenham, 5 p.c. basic Cons. Ord. ...	98—103xd
June 18	4	4	Do. 4 p.c. Perp. Deb.	120—125
Feb. 12	5½	5½	Chester United Ord.	39/6—41/6xd
June 18	7	9½	Colombo Ltd., Ord....	23/6—25/6xd
"	7	7	Do. 7 p.c. Pref.	17/—19/-
Mar. " 26	...	5	Colonial Gas Assn. Ltd. Ord.	22/6—24/6
"	8	8	Do. 8 p.c. Pref....	88— 91
Feb. " 12	5	2	Commercial Ord.	91— 96
June 4	...	3	Do. 3 p.c. Deb. Perp.	118—123
Feb. 12	...	5	Do. 5 p.c. Irred. Deb.... ...	118—123
"	6	6	Croydon sliding scale	101—106
"	5	5	Do. 'A' max. div.	99—104
"	...	4	Do. 4 p.c. Irred. Pref.	99—104xd
June " 18	4	4	Do. 4 p.c. Perp. Deb.... ...	120—125xd
"	...	5	Do. 5 p.c. Perp. Deb.... ...	140—150
Feb. " 12	8½	7½	Derby Cons. Ord.	99—104xd
June 18	4	4	Do. 4 p.c. Red. Deb.	97—102
Feb. 12	5	5	East Hull Ord.	100—105
"	5	5	East Surrey 'B,' 5 p.c.	120—125
"	6	6	Do. 6 p.c. Cum. Pref.... ...	120—125xd
June " 18	5	5	Do. 5 p.c. Irred. Deb.	110—120
Feb. 26	6⅝	6⅝	East Wight Cons. Ord.	97—102
Mar. 12	5	5	Eastbourne 'A'	90—100
"	3½	3½	Do. 'B'	20/—22/-
Nov. " 18	...	5	Gas Consolidation Ord. 'A'	20/—22/-
"	...	5	Do. Ord. 'B'	19/6—21/6
May " 14	...	4	Do. 4 p.c. Red. Cum. Pref.	22/3—23/3
Feb. 12	5	5	Gas Light & Coke Ord.	80— 85
"	3½	3½	Do. 3½ p.c. max.	101½—104½
"	4	4	Do. 4 p.c. Con. Pref.	100—103
Dec " 31	...	3½	Do. 3½ p.c. Red. Pref.... ...	96— 99
June 4	3	3	Do. 3 p.c. Con. Deb.	103—106
"	5	5	Do. 5 p.c. Deb.	104—107
"	4½	4½	Do. 4½ p.c. Red. Deb.	99—102
Mar. 26	...	3½	Do. 3½ p.c. Red. Deb.... ...	103—108
Mar. 12	5	5	Gloucester Cons. Ord.	13½— 15½
Feb. 12	2	Nil	Great Yarmouth (8½ p.c. max)	135—140
Feb. 26	7½	8½	Guildford Cons. Ord.	103—108
Feb. 26	5	5	Hampton C'ts, 5 p.c. Cons. Ord.	100—105
"	5	4½	Hartlepool G. & W. 5 p.c. Ord.	87— 92
June 4	6	5	Hastings & St. L. (5 p.c. Std.)	83— 88
"	5	3½	Do. (3½ p.c. Std.)	22/—24/-xd
June 18	7½	6	Holyhead & N. Wales Ord.	95—100
April 16	5	3½	Hornsey 3½ p.c. Std.	120—125
"	6 7/16	5⅜	Do. 5 p.c. Std.	122—127
May " 14	8½	8	Imperial Continental Cap.	98—102
Jan. 29	3½	3½	Do. 3½ p.c. Red. Deb.... ...	146—151
April 16	7½	7½	Lea Bridge Co., Cons. Ord.... ...	116—119
Feb. 12	5½	5½	Liverpool 5 p.c. Ord.	128—138
Mar. 12	7½	8½	Luton Cons. Ord. 'A'	110—115
"	6½	6½	Do. Ord. 'B'	

When ex-Dividend	Dividends Interest.% Last Yr.	Pref. Yr.	NAME.	Quotations June 26
Jan 15	...	7	Malta & Med'n., 7 p.c. 1st Pref.	100—110
"	...	7½	Do. 7½ p.c. 2nd. Pref.... ...	105—115
Feb. " 12	5·225	5·225	M.S. Utility 'A' Cons.	98—103
"	3·722	3·722	Do. 'B' Cons.	70— 75
"	5	5	Do. 'C' Cons.	98—103
"	...	4	Do. 4 p.c. Cons. Pref.	98—103
April 30	4	4	Montevideo, Ltd. Ord.	127—132
Feb. 12	5⅛	5⅛	Newcastle and Gateshead Ord.	24/—26/-
Dec. 31	...	3½	Do. 3½ p.c. Perp. Deb.	98—101
Mar. 12	7	6	Newport (Mon.) Cons.	112—117
June 18	5	5	Do. 5 p.c. Perp. Deb....	119—124xd
April 30	6⅝	6⅝	North Middlesex 6 p.c.	130—135
"	5	5	Do. 5 p.c. Pref.	103—108
Feb. " 12	...	5	Northampton Cons.	104—109
Jan. 29	10	10	Oxford, Cons. Ord.	180—200
June 18	5⅛	5⅛	Plymouth & Stone Ord.	103—108xd
"	8½	8½	Do. Addl.	14½—16½xd
"	7⅞	7⅞	Do. New	14— 16xd
Mar. 12	...	5	Do. 5 p.c. Deb. Perp....	117—122
Feb. 12	7½	7½	Portsmouth & Gosport Cons.	140—145
"	5	5	Do. 5 p.c. max.	100—105
"	10	10	Preston 'A'	170—190
"	7	7	Do. 'B'	132—137
"	2	4	Primitiva Holdings, Ltd. Ord.	10/—12/-
June 4	...	6	Do. 6½ p.c. Red. Cum. Pref.	100—105
Feb. 12	5	5	Reading, 5 p.c. max.	100—105
June 18	4	4	Do. 4 p.c. Perp. Deb....	98—103xd
Feb. 12	5	5½	Romford, Ord.	105—110
Mar. 26	...	4	Do. 4 p.c. Debs. Red....	97—102
June 18	7⅓	5½	Severn Val. Ltd. Ord.	21/6—23/6xd
Feb. 26	...	4½	Do. 4½ p.c. Cum. Pref.	20/—22/-
"	6½	6½	Sheffield Cons....	138—143
Dec. 31	...	4	Do. 4 p.c. Red. Deb.	100—105
June 4	6	5	South East'n Gas Ltd. Ord.	21/ —23/
Feb. 26	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	19/6—21/6
"	4	4	Do. 4 p.c. Irred. Cum. Pref.	19/—21/
Feb. " 12	5	4	South Metropolitan Ord.	94½— 97½
"	...	6	Do. 6 p.c. Irred. Pref....	122 —127
"	...	4	Do. 4 p.c. Irred. Pref.	99 —104
"	3	3	Do. 3 p.c. Perp. Deb.	94 — 99xd
June 18	...	5	Do. 5 p.c. Red. Deb.	98 —103
Jan. 15	...	5	South Suburban Ord. 5 p.c.	110 —115
Jan. 29	5	5	Do. 5 p.c. Perp. Pref....	105 —110
"	...	4	Do. 4 p.c. Perp. Pref....	99 —104
"	...	3½	Do. 3½ p.c. Red. Pref....	98 —103
June 4	5	5	Do. 5 p.c. Perp. Deb....	120 —125
April 30	5½	5½	South West. G. & W. Ltd. Ord.	19/—21/-
Feb. 12	5	5	Southampton Ord.	104 —109
Jan. 29	6	6	Sunderland Ord.	123 —128
Feb. 12	4½	3½	Swansea Ord.	83 — 88
"	...	5½	Do. 5½ p.c. Red. Pref.	100 —105
Mar. 12	7	6½	Swindon Cons. Ord.	115 —120
"	5	5	Tottenham Ord.	110 —115
"	5	5	Do. 5 p.c. Pref.	105 —110
"	5½	5½	Do. 5½ p.c. Irred. Pref.	116 —121
June 4	4	4	Do. 4 p.c. Perp. Deb....	100 —105
"	7½	7½	Tunbridge Wells, 4 p.c. Sliding	125 —130
"	7	6	U. Kingdom Ltd. Ord.	22/—24/-
"	...	4½	Do. 4½ p.c. 1st Cum. Pref.	20/—22/-
May 14	...	4	Do. 4 p.c. 1st Red.Cum.Pref.... ...	19/6—21/6
"	4½	4½	Do. 4½ p.c. 2nd Non.Cum.Pf.... ...	19/6—21/6xd
June 18	4½	4½	Do. 3½ p.c. Red. Deb....	100 —105
Mar. 12	...	3½	Uxbridge, &c., 5 p.c. Cap.	127 —132
May 14	6⅝	6⅝	Do. 5 p.c. Pref.	104 —109
"	5	5	Do. 5 p.c. Perp. Deb.	120 —125
June 4	5	5	Wandsworth Cons.	110 —115
Feb. 12	5	5	Do. 4 p.c. Pref....	100 —105
"	...	4	Do. 5 p.c. Irred. Deb....	119 —124xd
June 18	5	5	Do. 4 p.c. Irred. Deb.... ...	99 —104xd
"	4	4	Watford & St. Albans Ord.	110 —115
Feb. 12	5	5	Do. 5 p.c. Pref.	108 —113
"	...	5½	Do. 5½ p.c. Pref.	115 —120
"	5	5	Weymouth Ord. (5 p.c. Basic)	97 —102
"	11	11	Woking District "A" Ord....	190 —200
"	7·7	7·7	Do. "B" Ord.	133 —138
"	8	8	Wolverhampton Cons. Ord.	123 —128
Mar. 26	5	5	York Cons. Ord.	105 —110